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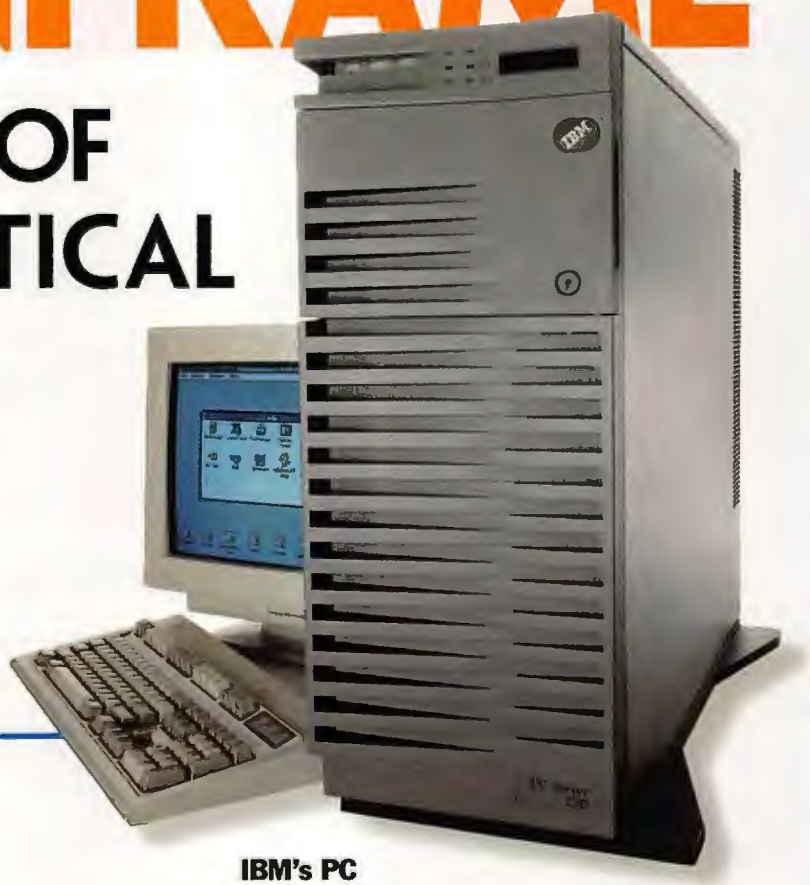
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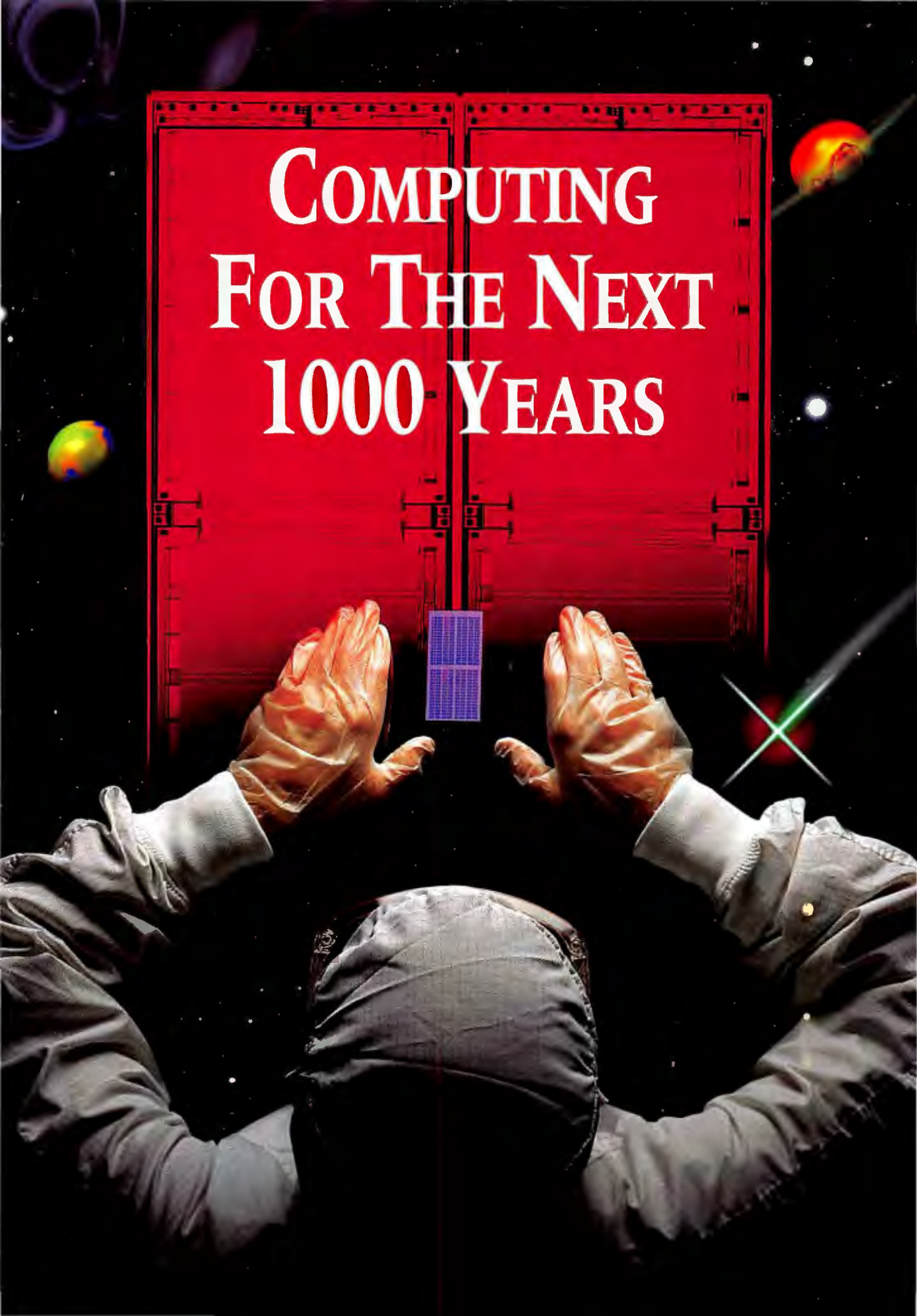
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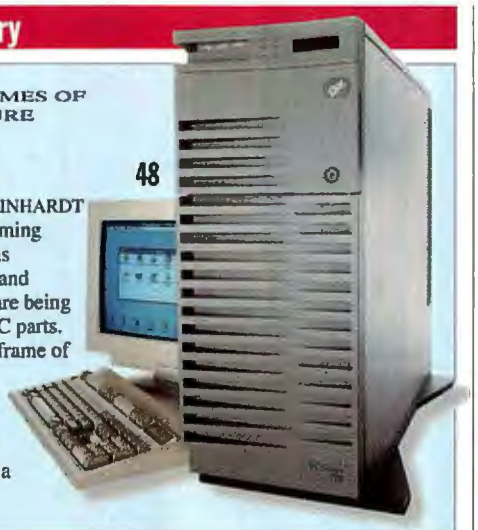
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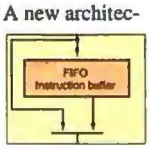
Isochronous Ethernet and ATM race to bring video to your desktop.

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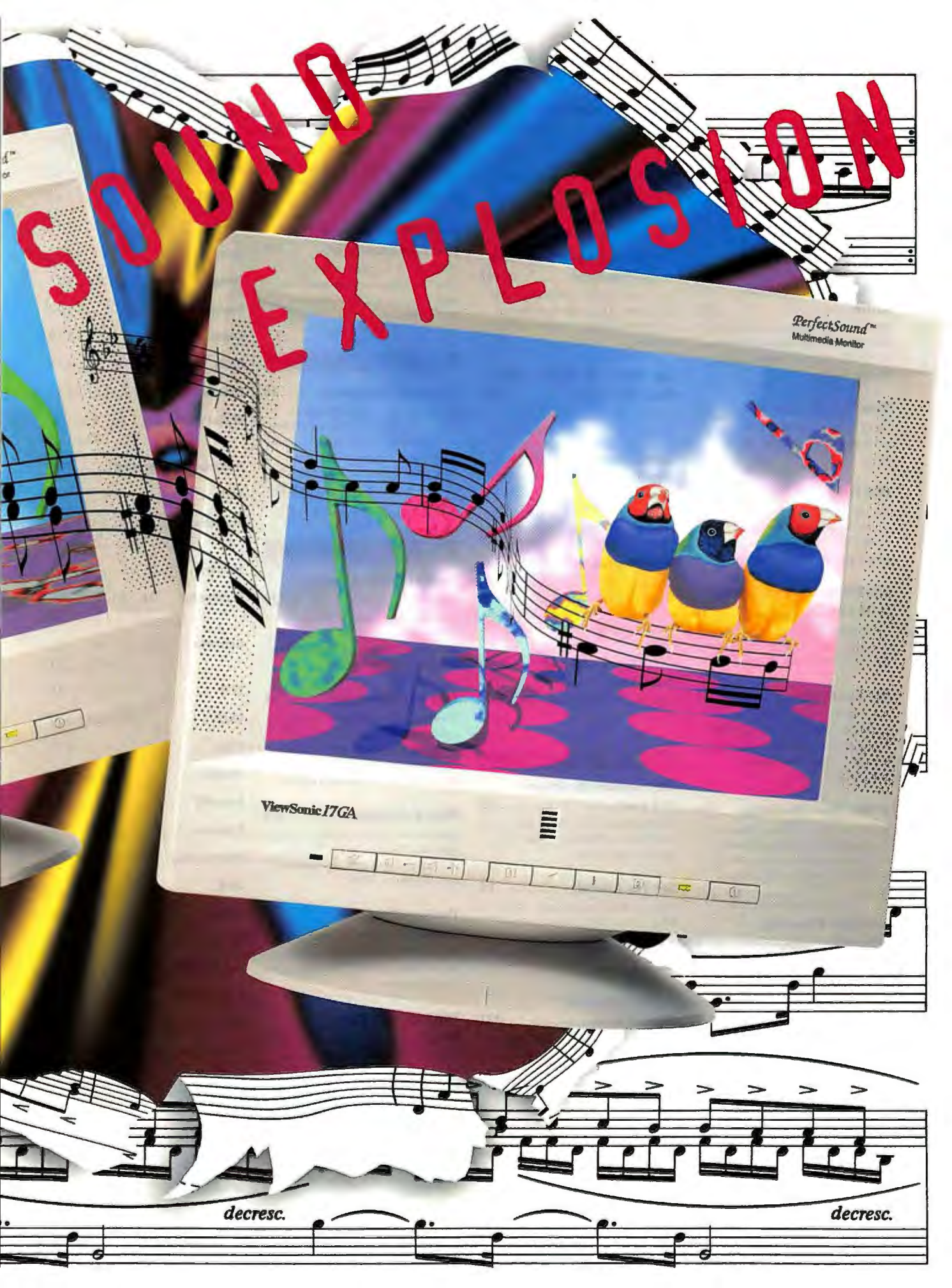
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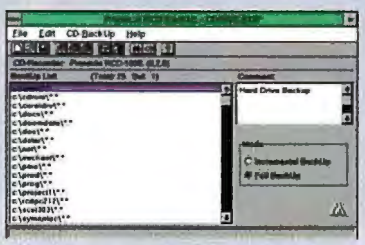
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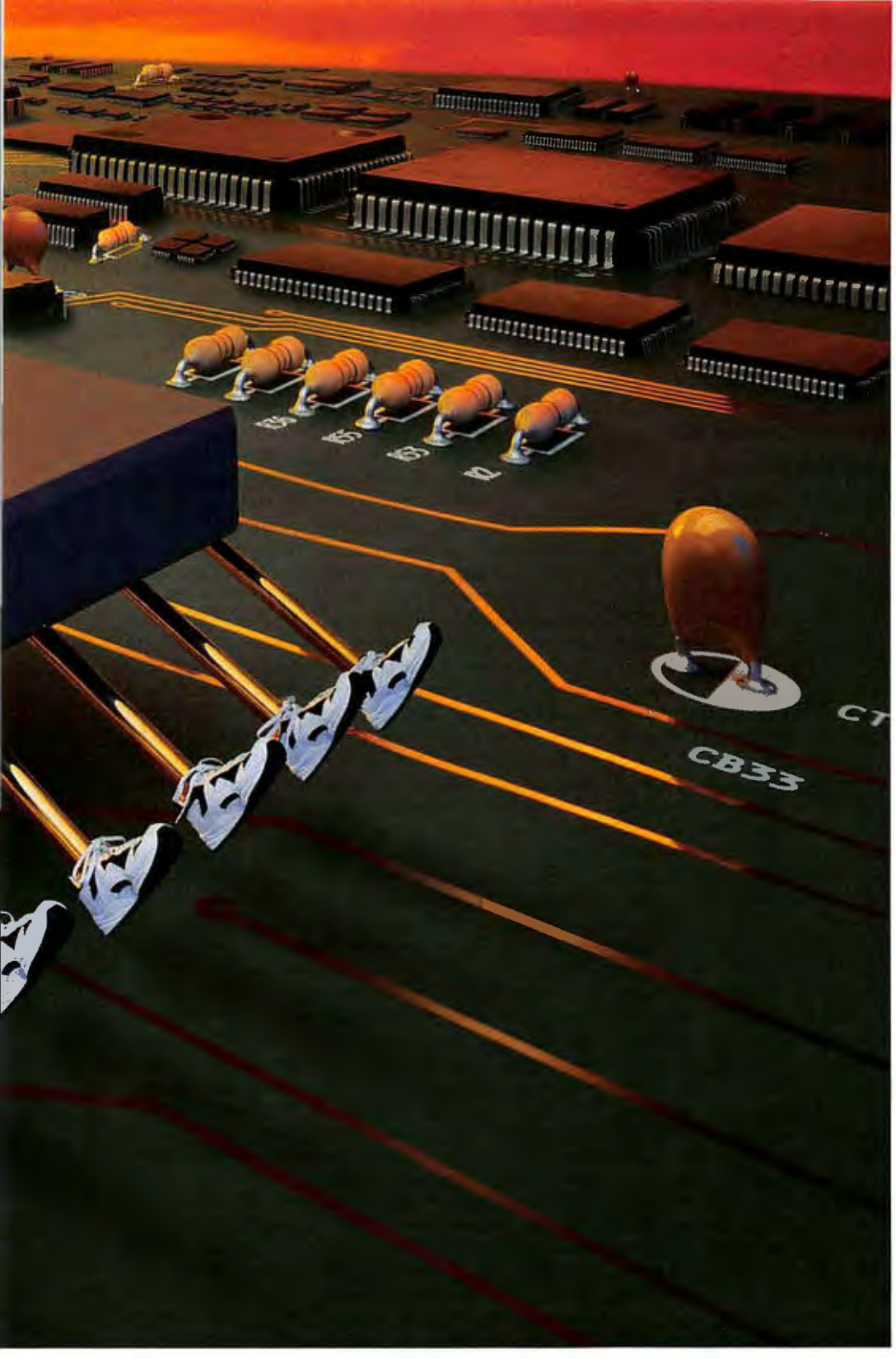
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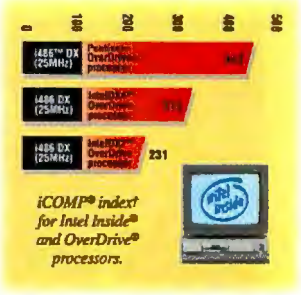
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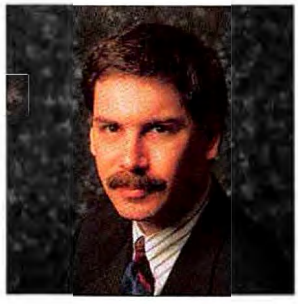


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Let's Put on a Show!



We send seven editors and 10 portables to CeBIT. Hilarity ensues.

Every year, BYTE sends a passel of editors to the mammoth CeBIT trade show in Hannover, Germany. This year, we did something new—we inaugurated the Best of CeBIT awards. The reason: Technology is global. There's no reason for us to limit our awards to the ones we give at Comdex in the U.S. and Computex in Taiwan.

I am delighted with the awards we presented. You'll find a full report on page 34, but let me state now and for the record that some of the new products I saw at CeBIT are absolutely stunning. The two that most impressed me are the programming environment called Wizdom Pro, which won our Best of Show award, and Taylor II, an amazing simulation engine for designing and troubleshooting the flow of physical goods. Neither of these products are currently available in the U.S., which means that those of us based here will not see them at the same time our European colleagues do. That's a shame, but it's also a reflection of an important market dynamic: The computer industry is strong and growing in the U.S., but it's growing even faster elsewhere.

It wasn't easy coordinating our coverage for this show. We had 10 portable computers and two printers among us, but, alas, at the guesthouse where we were all staying, we had only one reliable phone line back to the states.

Unfortunately, we couldn't plug our modems into the guesthouse's system, so we had to use the acoustic coupler that I had thrown into my briefcase at the last minute. We had better luck at the trade show itself, where we could plug our modems directly into the phone system, just like back home.

Having just seven editors to cover a trade show consisting of 6178 exhibitors with more than 700,000 attendees was a daunting proposition. Thus, in recognition of the BYTE editorial staff's hard work, I want to point out just a few of the people who made our comprehensive coverage of this show possible:

First, I'd give a gold medal to Dennis Barker, our chief of correspondents. In addition to organizing and coordinating the awards planning before the show, he demonstrated a real dedication to the magazine by eschewing sleep in the last critical hours before our awards ceremony. He was still up writing the awards script when I retired Thursday night at 2:00 a.m. And when I came down for breakfast at 7:00 a.m. on Friday, he was still there, pounding away at his computer. Dennis clinched this award, however, by skipping the beer-hall bash after the awards ceremony so he could write the press release.

Then there was Dave Andrews, a news editor. Dave is a great guy and a gifted reporter, but he has the *worst* travel karma of anybody I've ever met. First, he missed his Lufthansa flight to Germany, although he did manage to find an alternate route via KLM. When he arrived in Hannover, unfortunately, his luggage was nowhere to be seen. After two days of wearing the same jeans, Dave went out to buy clothes, but the store didn't take credit cards, and worse, he couldn't find any shirts that fit right.

Our Frankfurt bureau chief, Rainer Mauth, presented half the prizes. He had agreed to do this beforehand and did a great job. What he didn't tell me, however, was that before CeBIT, he had never spoken before a crowd of people in English. You'd never know it. Rainer had excellent presence on the stage, and his comments about the winning products were incisive and articulate.

CeBIT was a rewarding trip for the BYTE editorial brain trust. When I got on the plane to head home, however, I discovered the adventure wasn't quite over.

On the flight back, I had the good fortune to sit in the cockpit of the Airbus 340 during takeoff. The Airbus is a technological masterpiece—it's a fly-by-wire airplane, which means that all the pilot's commands are relayed to the control surfaces and engines via computers and electronics, not direct hydraulics, as in older planes. The Airbus has three flight computers that "vote" on all critical commands; if one of the computers gives a different result, the remaining two override it.

Before takeoff, I tried to break the ice with the pilot by finding some common interests. "I hear this plane is a flying computer," I said. Bad move. The pilot tensed up. He said, "I am not too interested in computers." He likes flying—not running a computer console. Fortunately, he proved to have excellent mastery of the Airbus 340; the flight was glass-smooth and uneventful. And Dave Andrews' luggage even made it back on the same flight. ■



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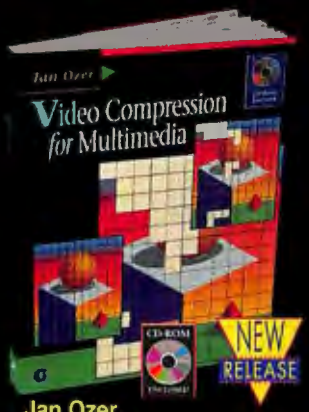
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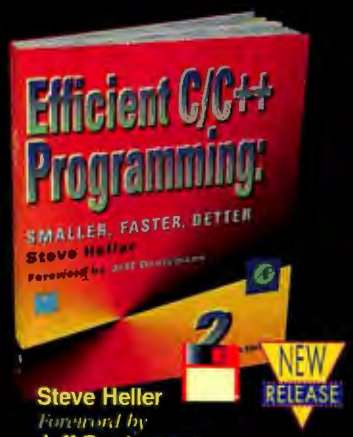
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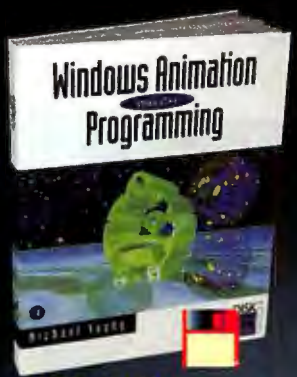
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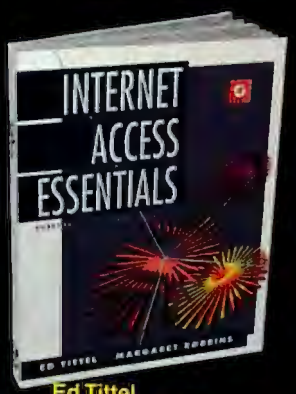
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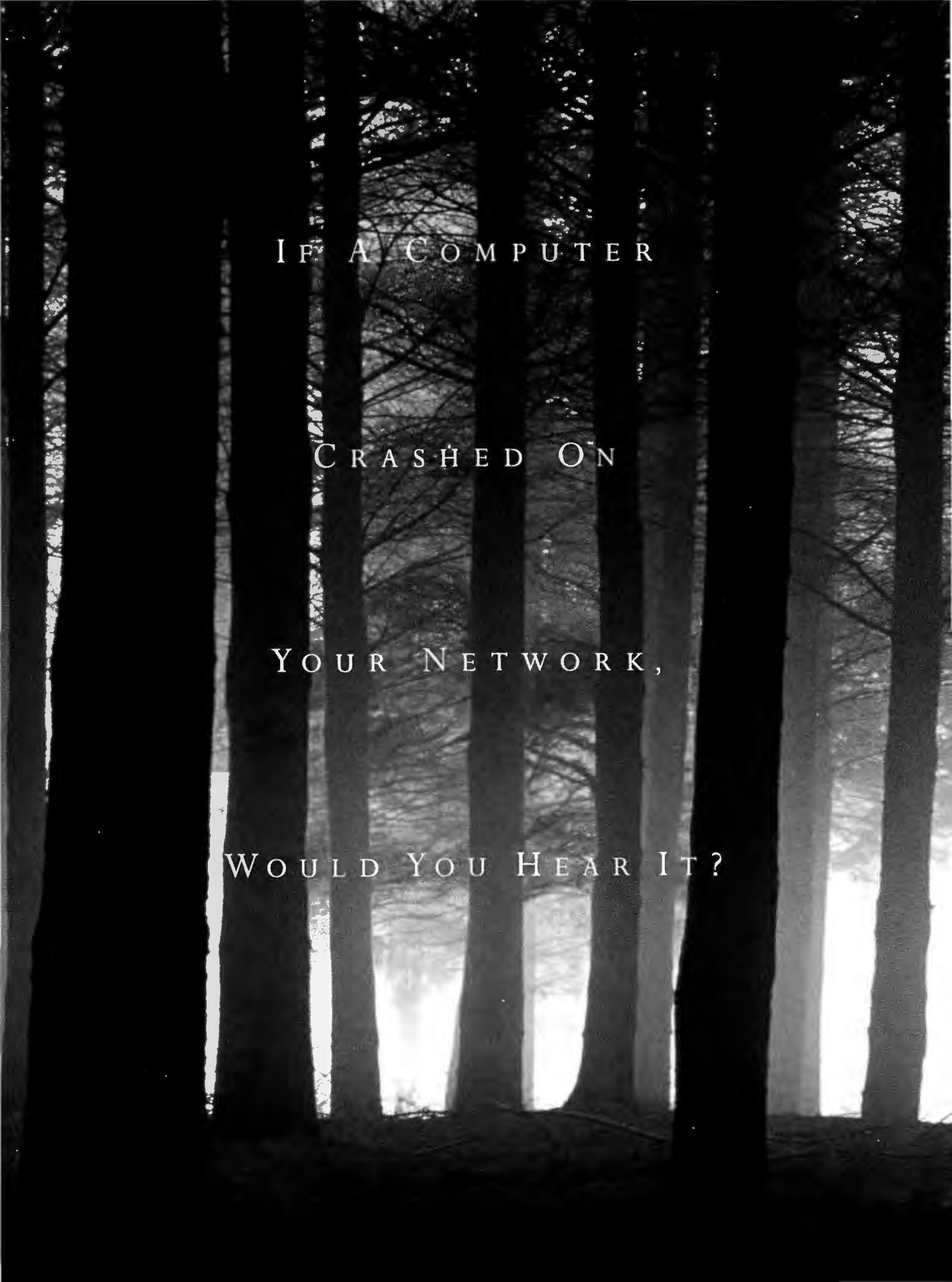
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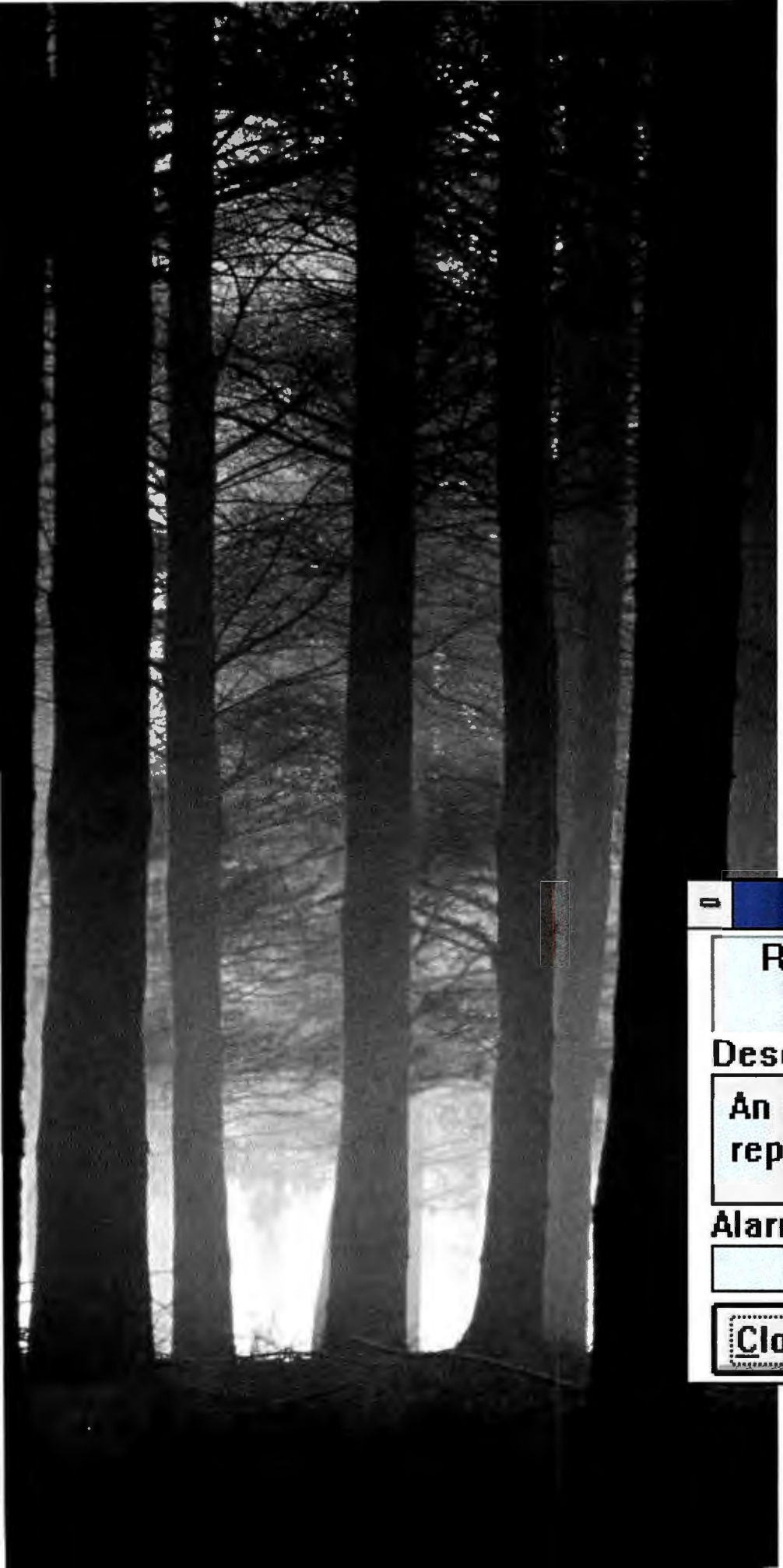
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If A Computer
Crashed On
Your Network,
Would You Hear It?



Received: 3/03/95 08
Client: Dylan Page

Description:

An IntelliSafe Hard Drive
replacement before actua

Alarm Details

Close Next Previo

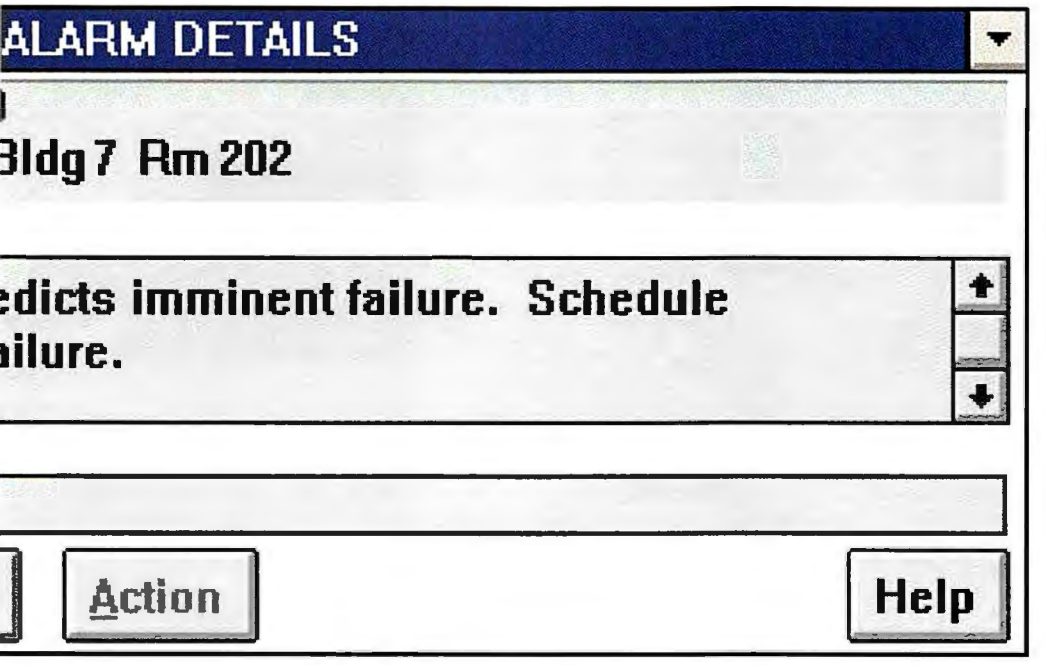
NOT IF

IT NEVER

HAPPENED.



Introducing the new Compaq Deskpro



COMPAQ





Managing computers on a network requires knowledge, skill and a bit of intuition. Okay, a lot of intuition. Somehow, you have to know what's going to happen. Before it actually happens.

Wouldn't it be great if you had just a little help? A crystal ball? A sixth sense, perhaps?

Funny, we were thinking the same thing. Which is why we built the new Compaq Deskpro.* A computer that can actually send a report of its status directly to the desk of the network administrator.

HAVE COMPUTERS BECOME MORE HUMAN? WELL, THIS ONE CAN TELL YOU WHO IT IS, WHAT IT'S DOING, AND HOW IT FEELS.

Imagine being warned before a hard drive on another floor (or another city) seized up. Or taking a complete PC inventory right from your desk. (Certainly not the kind of cooperation you'd expect from a machine.)

COMPAQ

We call it Intelligent Manageability. You'll likely call it "I'm glad someone finally thought of that."

How do we know? Maybe it had something to do with intuition.

COMPUTERS THAT TAKE CARE OF THEMSELV

Research proves what you've known all along: only 20% of the lifetime cost of your company's PCs is the initial cost.* The other 80% comes from all the things you do to manage them—like configuring, servicing, upgrading and just keeping track of who's got what. Isn't it time someone found a way to change that?

Asset Management 101. Our newest Compaq Deskpro is the first PC that's as concerned about cutting costs as you are. It all starts with the Intelligent Manageability we mentioned a page ago: a Compaq-designed combination of hardware and software that gives you a new level of control over your networked PCs.

Until now, taking stock of your PC assets has always required you to physically visit your computers one at a time. At every stop, you'd have to examine the PC, take serial numbers, check software, open it up and take a look inside. It's a process that could literally take days.

The new Deskpro changes that. Working closely with the leading companies in the world of LAN management, we built in some powerful features that can be tapped by their new software tools.

And the result is stunning: Now, as network manager, you can look into a Deskpro PC anywhere on the network to take inventory. You can retrieve hardware specifications, including make, model and serial number for the PC, hard drive and monitor, and revision numbers for the system board and ROM. You can also identify system software and drivers.

It's not only good knowledge to have. It makes the job of maintaining and updating PCs vastly more simple.

Fire prevention. When people decide to stop working for you, they usually have the courtesy to give notice. Computers, on the other hand, seem to enjoy the element of surprise.

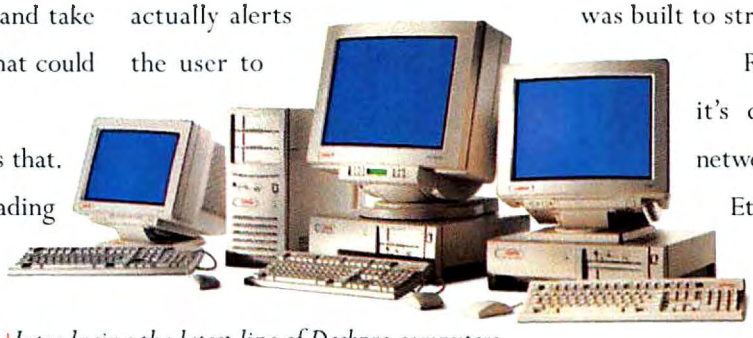
Again, Deskpro will be changing things. Its Intelligent Manageability actually alerts the user to critical potential problems before they can turn into real ones.

Every time you power up the new Deskpro, its IntelliSafe™ hard drive conducts its own diagnostics. If any of its performance parameters has fallen below acceptable standards, the user is notified. So instead of responding to an emergency, you have ample time to take corrective action—replacing the drive at no expense under the Compaq Pre-Failure Warranty.™

In addition, our Environmental Fault Protection constantly monitors the internal temperature of your Deskpro to make sure it isn't working under conditions which might imperil your valuable data.

Networking is in our blood. Because setting up a personal computer on a network has turned into one of the most time-consuming pastimes in corporate America, the new Deskpro was built to streamline the process.

Right out of the box, it's configured for your network, with a 32-bit PCI Ethernet NIC or an IBM Token Ring adapter



Introducing the latest line of Deskpro computers

* Source: Gartner Group

COMPAQ

already installed. The drivers are optimized and industry-standard connectors are in place. And with its simple configuration tools, Deskpro helps reduce the complexity of setting up desktop network software.

Under the hood. The thing that makes our Intelligent Manageability most appealing, of course, is the fact that it's built into an enormously powerful and efficient computer.

With Deskpro, you can choose your processor, from a DX2/50MHz to the most powerful Pentium. And every model delivers the enhanced performance of Compaq's new TriFlex™/PCI architecture. In fact, in our latest crop of Deskpro PCs, higher performance is something you can literally see and hear.

Thanks to PCI local bus graphics, you get crisp, responsive graphics even in everyday business applications. (Select 586-class Deskpro models are available with higher-performance VRAM graphics.)

In multimedia models, you get the speed of our new QuadSpeed CD-ROM and the CD-quality sound of built-in Enhanced Business Audio.

Open and accessible. Needs change, goals change and people change. The good news is, a Deskpro computer can change every bit as quickly.

It opens without any special tools. The system board slides out, making it easy to upgrade the processor or add extra RAM. The PCI expansion slots are easily accessed. And the drive cage swings out to make hard drive upgrades painless.

Plus, the Deskpro system board utilizes Flash ROM technology, which allows you to make future upgrades at the board level simply by running a software utility.

With the task of upgrading a PC reduced to minutes, you can allocate your time to more lucrative pursuits.

Future dividends. And then there are the benefits your business will be reaping down the road.

Since all Deskpro models have been designed with built-in power management features that meet the EPA's stringent requirements, they can actually consume less power.

(The savings in a month from a single Deskpro probably won't finance your retirement villa, but the savings from many machines over many years should have a nice effect.)

And when Windows 95 becomes available, Deskpro will make the job of managing your company's network of PCs even easier.

Using new management software tools provided by Compaq and our LAN industry partners, you'll be able to effectively monitor the health of all your networked Deskpro PCs — including the ones hard at work in your outpost six time zones away — without having to leave your desk.

You'll be able to configure your Deskpro so that if IntelliSafe hard drive failure becomes a possibility, it will send you a distress call across the network. Or automatically safeguard its data on a tape backup.

You'll even be able to have Deskpro send remote notification if it should detect potential problems with its built-in network interface card or internal operating temperature.

But then, what do you expect from a computer that takes care of itself?

ES? THIS COULD TAKE SOME EXPLANATION.



Introducing the new Compaq ProLinea

The original premise was simple: make a powerful, yet affordable, computer that doesn't come with all the headaches normally associated with the word "value." And in creating the latest Compaq ProLinea, we built on that premise—by taking the original apart.

We examined it from top to bottom, from the inside out, looking for ways to improve it. Looking to see what new technologies we could add.

THE LATEST PROLINEA HAS AN IMPRESSIVE SAVE FEATURE: IT'LL SAVE YOU MONEY, SAVE YOU TIME, AND SAVE YOUR SANITY.

In the end, we came up with more than a few improvements. Making ProLinea even harder to distinguish from more expensive machines. The fastest processors. Easy upgradability. Simplified maintenance. Features that make it easy to live with on the day you install it, and for years to come.

It all raises ProLinea to a completely new level. (Of course you'll still find the price within reach.)

And that should certainly put your mind at ease.

COMPAQ



Traditionally, the phrase "better value" has always meant someone's cut corners to give you a better price. At Compaq, however, we like to take a different approach.

The result is the new Compaq ProLinea: a family of computers that not only offers affordable prices, it pushes technology many steps ahead. Twelve, to be exact:

Number One. Our first improvement is something you'll notice before you even buy a ProLinea. You get to choose the processor you want—from very fast (486DX2/50MHz) to blindingly fast (Pentium/100MHz). This way, you don't have to buy more performance than you really need. And it's designed so that you can upgrade whenever you want.

Number Two. You may be familiar with the new standard bus architecture called PCI. Basically, it improves upon the previous technology by expanding the data path to 32 bits and radically speeding the flow of information to expansion cards and peripherals. And guess what: Compaq has already enhanced this standard with our new TriFlex/PCI architecture—which is built into every ProLinea model.

Number Three. The PCI architecture also boosts the performance of the graphics subsystem. So even if you're working with general productivity applications like word processors and spreadsheets, you can enjoy a crisp, responsive high-resolution display. If your uses demand more, select 586-class models are now available with higher-performance VRAM graphics.

Number Four. Forgive the acronyms, but there's also a PCI local bus IDE interface. This not only pays off in improved disk performance, but it supports up to four storage devices. Which means you can easily add another hard drive, tape backup or CD-ROM drive when needed.

Number Five. As long as we're on the subject of CD-ROM, multimedia ProLinea models now come with our new QuadSpeed drive (along with Enhanced Business Audio). This gives you faster access to the rich and vast references available on CD-ROM today, from national directories to archives of business publications.

Number Six. However large a hard drive may be, there are those who take it as a personal challenge to fill it up. With the new ProLinea PCs, however, we're determined to make that as difficult as possible. You can choose a configuration with a disk capacity of 270MB, 420MB or 720MB. Any of which should put you well ahead of your burgeoning files.

Number Seven. ProLinea comes with 8MB or 16MB of RAM, depending on the model. And you can easily expand it to 136MB or 192MB—enough to take advantage of new 32-bit operating systems, run several programs at once and work with spreadsheets the size of Madison Square Garden.

Number Eight. ProLinea is filled with features designed to make your life

LIKE MOST PC BUYERS, YOU'RE "BETTER VALUE," SO WE'VE CLEVERLY

COMPAQ

easier. It's not only pre-loaded with an extensive online help system and automated setup software, it now has redesigned documentation to help you quickly pinpoint information. It's also optimized to run new operating systems like Windows 95, which will make your future computing easier still. Every model supports the Plug-and-Play standard that will bring a new simplicity to the process of adding expansion cards. (If you add a new network interface card, for example, ProLinea will sense the change and automatically reconfigure its software to support it.)

Number Nine. You decide exactly how expandable you want your ProLinea to be. You can select a desktop model with three expansion slots and three expansion bays or a model with four of each. Or you can choose a five-slot, five-bay mini-tower model that offers maximum expandability without taking up too much of your space.

Number Ten. The new ProLinea PCs have been designed so you can get inside without any special tools. The system board slides out to accept extra memory or a processor upgrade. The hard drive cage swings out so you can swap disks without reaching into inaccessible, finger-bruising areas. And when you snap in a new Compaq hard drive, you won't have to configure any enigmatic jumpers. When you connect the cables, the settings have the good sense to take care of themselves.

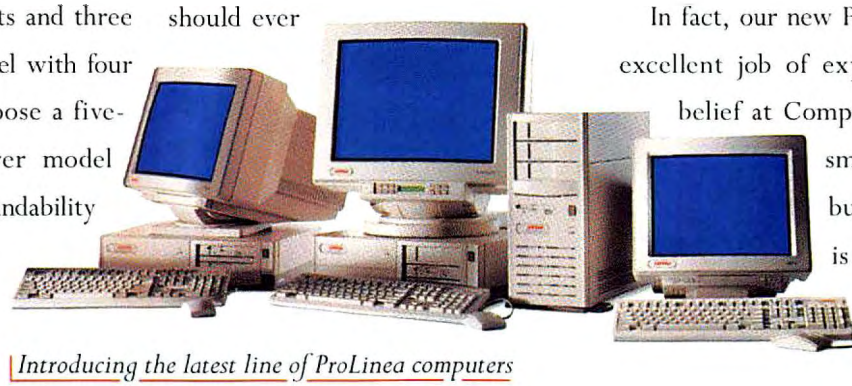
Number Eleven. The ProLinea system board now incorporates Flash ROM technology. That means basic system ROM can be updated without major PC surgery. If future system updates should ever become necessary, installing them will be no more difficult than running a software utility and clicking a few buttons on the screen.

Number Twelve. And what about the environment? Using a ProLinea won't by itself repair the ozone layer, but it's certainly a step in the right direction. For the sake of the atmosphere—and everyone who breathes it—our PC manufacturing process is completely CFC-free. And every model is now Energy Star-compliant, which means less wasted energy for the planet and less wasted money on your power bill.

PROBABLY SICK OF HEARING DISGUISED IT AS 12 IMPROVEMENTS.

These are the improvements that define our approach to value. (We think you'll agree, it's a lot more rewarding than cutting corners.)

In fact, our new ProLinea does an excellent job of expressing a core belief at Compaq: That is, the smartest way to build better value is to build a better computer.



Introducing the latest line of ProLinea computers



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Letters

Integrating Computers in Schools

Andy Reinhardt's article "New Ways to Learn" (March) is an excellent introduction to current computer technology in schools and the possibilities it entails. It will greatly aid my mission to get administrators and teachers in our middle school to discover these resources. My years of experience with this issue very much parallels what Reinhardt reports, including using much of the same software he mentions.

Gary Mattson
Marina Middle School
San Francisco, CA



I've been reading BYTE for almost 20 years because of its well-earned reputation for factual evaluations of hardware and software. Your issue on education is the antithesis. Computers belong in the classroom, not in a computer technology magazine. My wife, who teaches third graders, uses computers effectively by concentrating on what they do best for students. In 1994, her third-grade students competed against fifth graders in a national NASA/NSTA science contest and placed first and second in California and second in the nation. She *does not* use any of the "edutainment" materials by the parfait providers featured in your multimedia splash.

Larry Severson
science@macropress.com

Editorializing

I found Rafe Needleman's March Editorial about the Pentium—and life for that matter—to be a great insight on the human learning condition. Flaws sometimes have to be accepted as fact—as real as taxes and death.

Greg Zerkis
zerkis@radiomail.net

Rafe Needleman incorrectly excuses Intel for the Pentium division error. While I agree that certain classes of bugs are inevitable even after a rigorous test suite, the floating-point divide glitch was inexcusable. This is not some esoteric bug that would only show up after an odd combination of instructions was executed. It requires less than a second to determine that each element of a lookup table is correct.

John Waring
Orleans, Ontario, Canada

8-mm Tape Blunder

Our March Lab Report, "26 Safeguards Against LAN Data Loss" does injustice to Exabyte. In 1987, Exabyte adapted tape drive transport mechanisms and media for 8-millimeter tape systems from the consumer video industry. Since then, Exabyte has completely redesigned the systems for data processing, so the drives are no longer videocassette products. In comparing 8-mm tapes to DLT tapes (page 154), we should have stated 16,000 hours for the head life of an 8-mm tape rather than the 2000 hours of earlier models. Another innovation is that Exabyte's drives with the XL suffix, such as the EXB-8505XL drive we tested, hold 7 GB of uncompressed data, as stated in our roll call but not in the article's introduction. We apologize to Exabyte and to other vendors of 8-mm tape drives for these errors.—Eds.

Simplifying WWW Publishing with SGML

In the text box "A Vision for a More Sophisticated HTML" (News & Views, March, page 30), the idea that different browsers support different levels of HTML is just plain crazy. It would be much simpler to have all HTML browsers accept *full SGML* tagging rather than to create more versions of HTML. All browsers would render all tag sets, including all varieties of HTML and even incompatible HTML versions and tag sets that haven't even been developed yet. Documents could have a unique tag set, and authors and users would gain control of the rendering. The rendering table should be dynamically loaded; it is not necessary to have full SGML smarts in an SGML-rendering browser.

Bob Goldstein
Computer Center
University of Illinois at Chicago
bobg@uic.edu

The Internet Mirrors Society

In the March Commentary "Bosnia On-Line," I was dismayed to see George Bond uncritically swallow Canter and Siegel's self-serving pose as victims of "antibusiness bias." Thousands of businesses operate on the Internet without incident by observing basic Internet courtesies. If Bond really wants to see the Internet become more civilized, he ought to support its taboos against antisocial behavior. Treating people whose conduct earns them scorn and ostracism as victims isn't good for real-world society, and it wouldn't be any better for Internet society.

Stephen Brinich
Arlington, VA
steve-g@digex.net

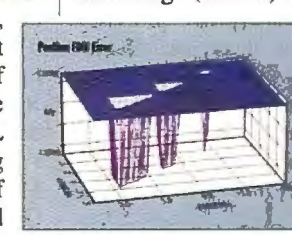
Putting Pattern Recognition Technology to Work

Edmund DeJesus' February article "Face Values" was interesting and inspiring. I think I'll keep a Bill Gates photo handy when ATMs with facial recognition become operative.

Alberto Quario
Computer Science Dept.of
Milan State University, Italy
quario@dsi.unimi.it

The Pentium FPU Bug Unveiled

Tom Halfhill's "The Truth Behind the Pentium Bug" (March) is the most accurate piece I have seen on the subject. Much has been written about the Pentium processor episode, most of it flat wrong. Good work.



Mike Barton
Manager of Technical Applications
Intel Software Technology Lab

Native-Mode Benchmark Requests

Rick Grehan's March article on BYTE's new native-mode cross-platform benchmark suite was well written, and I look forward to trying it on several of our systems that have our new IDT/Mips R4700 processor. The earlier suite was always one of the first things we ran when a new system became available, and several

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OEM's included the results in marketing brochures. Please send me the suite.

Scott Gardner
Manager, Systems Technology Group
Integrated Device Technology
Santa Clara, CA

To receive a copy of BYTE's new low-level cross-platform benchmarks, send E-mail to editors@bix.com and include your mailing address with a list of the platforms you'd like. Each platform description should state the CPU type and OS. We'll send you disks that include full documentation and source code with DOS executable files. You may compile the tests for new platforms as you need them. We do have a few stipulations regarding how to report results, so please read the read.me file carefully. Soon we will post these benchmark tests at an ftp site, on CompuServe, and on the World Wide Web. If you have technical problems or questions, contact Rick Grehan at rick_g@bix.com or send E-mail to editors@bix.com. We will also appreciate feedback concerning your experiences putting these tests to work.—Eds.

Vines on the Enterprise

Your February software roundup entitled "Networks for the Enterprise" proposed to deal with the major "enterprise" NOSes (network operating systems), but it did not include an evaluation of Banyan Vines. The reason? "Hardware incompatibility forced us to drop the product from our evaluation." Banyan *invented* enterprise networking and Vines is the *only* NOS that is up to the demands of the enterprise.

John Daggan
Senior Network Analyst
727-1881@mcimail.com

BYTE'S Past

I found Jon Udell's February article on NetWare informative, but my interest was piqued when I read that the original server was named Guernsey. I was born and raised in the Channel Island of Guernsey, 20 miles off the coast of France. What possessed you to use such an unusual name?

Rob Fulwell
miser@maxwell.ee.washington.edu

The BYTE building, in scenic downtown Peterborough, New Hampshire (pop. <5000), was the original headquarters of the American Guernsey Cattle Club. When BYTE moved in, many boxes of cattle registrations and breeding records moved out. For a while, our editors enjoyed free Guernsey milk from the vending machines. Incidentally, we named one of our servers Ourtown because Peterborough was the location that inspired Thornton Wilder's Our Town.*—Jon Udell*

The OS/2 and Windows War

Barry Nance's "Big Blue's Speed Trip" (March) sounded like it was written by a politician. OS/2 advocates are getting scared of Windows 95, just like politicians up for reelection with the polls against them. Nance states that "Warp is a more mature operating system than...Windows 95," and "Unlike Warp, Windows 95 will have a hard time running in 4 MB of RAM." Not only are these statements false but his article doesn't substantiate them. I'm running Windows 95 on a 386 with 4 MB of RAM, emulating a NetWare server. Granted, our 386 runs about one-fifth the speed of our $40,000 Compaq server, but that's pretty good for a $500 machine.

Earl and Cathy Malmrose
malmrose@cyberspace.com

What a pleasant surprise to read your thorough article on OS/2 (aka Warp). I was a reluctant convert to OS/2 when 2.0 was released, and I wasn't prepared for the difference a robust OS would make in the day-to-day use of my computer. I went with OS/2 to use SAS Institute's Statistical Analysis System for OS/2. I stayed with OS/2 because I couldn't believe the difference it made for my DOS applications. That was on a 20-MHz 386SX with 8 MB of RAM. With Warp and 16 MB on a Pentium, it's even nicer. But the performance improvement from changing hardware pales compared to the difference that moving from DOS (and intermittent use of Windows) made. That was three years ago. Those who make the shift now will be even more favorably impressed by OS/2.

Michael S. Lundy, M.D., M.S.
76420.1554@compuserve.com

Why I'm a 20-Year Subscriber

I read a variety of PC magazines but subscribe to only a few. BYTE is on that short list, and the March issue exemplifies why: In the Lab Report, your explanation of how each of the tape systems work filled a gap in my understanding. Also, George Bond's "Bosnia On-Line" reminded me that as the technical becomes more commonplace, the trials and tribulations of the real world will intrude. Finally, "New Ways to Learn" helped me think of better ways to use my organization's PC tools to improve employees' skills.

Theron Patrick
TheronP@aol.com

FIXES

In the Lab Report's roll call (March, page 160), the first number cited in the column entitled Sustained Transfer Rate Compressed KBps is the Average Access Time in MBps.

In testing many IBM ThinkPads, we found that in our March review of the ThinkPad 755CD (page 129), the indexes for the Integer Index and the Floating-Poing Index are wrong. Its integer index is .626 (not .26), and the FPU index is .37 (not 0.14).

In our February issue (page 24), the phone number for Vitec (France), winner of last Comdex's Best Multimedia Hardware award, included a typo. The correct phone number is +33 1 46 73 06 06. ■

COMING UP IN JUNE

- **DIGITAL CASH**
  Six proposed standards for secure transactions over the lines.
- **SUPPORTING VIRTUAL OFFICES**
  How Xerox supports and manages its remote work force.
- **39 V.34 MODEMS**
  Test results of 39 sets of 28.8-Kbps modems, both external and PCMCIA models.
- **SPECIAL REPORT: MOBILE COMPUTING**
  The technical challenges facing developers of portable hardware and networking solutions.
- **SPREADSHEETS FOR OS/2**
  If you have just chosen Warp, this review will help you choose a spreadsheet that runs on it.

If you think Exabyte is just 8mm, think again. Today, Exabyte is Everywhere.

- High capacity
- Superior reliability
- Software compatibility
- Worldwide support
- Tape media products
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PC DATABASES

Desktop Databases Pack More Power

PC database vendors are touting the ability of their products to scale from the desktop to the enterprise. But a closer look at today's PC databases reveals that vendors' definitions of scalability vary widely.

BY JANE RICHTER

You're going to hear a lot about database scalability in the coming months. The PC's ever increasing capabilities let vendors deploy powerful database applications on the business desktop. But a close examination of PC databases reveals that definitions of scalability can vary widely.

An early definition of *scalability* referred to a Scalable Processor ARChitecture (the ANSI/SPARC standard) used to implement different technologies with hardware components of potentially many different sources and sizes. To be scalable, a system must have the ability to add or replace components in the system architecture. In today's software market, two complementary forms of scalability exist.

In its first form, scalability refers to the ability of an application to support multiple, concurrent processors. This horizontal scaling allows users to increase processing power without having to change applications, operating systems, or even computers. In this scenario, when you add a CPU, the system transparently handles data location and transaction distribution.

In its second form, scalability is the ability to create an application for potential use on many different computers and platforms. In the strictest sense, this type of scalability, called *vertical scaling*, refers to the ability to move an application among multiple computing platforms.

Vertical scaling's success requires equivalent database products across all platforms and depends upon the consistency of the languages and APIs between platforms. Only a limited number of products support this type of vertical scaling for the PC user. Ashton Tate, creators of dBase, published equivalent versions of dBase for the DOS, Mac, and Unix platforms (Borland, which acquired Ashton Tate, has yet to do so). Gupta's SQLBase also supports vertical scaling between its DOS, NLM (NetWare loadable module), Windows, NT, SunOS, and OS/2 offerings. Oracle's Workgroup 2000 (Personal Oracle7, Oracle Objects for OLE, and the upcoming Oracle Power Objects) allows applications to run interchangeably between Windows, Mac, and OS/2 versions.

However, many other database vendors define scalability as the ability to use a single application, or front end, to access data and services on multiple computing platforms, or back ends. With front-end scalability, applications designed on a single platform (typically DOS, Windows, or Mac) access data stored on a variety of back-end products and platforms. In addition to consistency between languages and APIs, front-end scalability also requires tools to support communication and reliable data transfer between various hardware platforms and software packages.

Many full-featured database products, such as Borland's Paradox and dBase software, Lotus Approach, Microsoft Access, and FoxPro (including the forthcoming Visual FoxPro), allow front-end application development and offer access to data stored on a variety of database servers, including MS SQL Server, Oracle, Sybase, and those offering ODBC (Open Database Connectivity).

Database Checklist

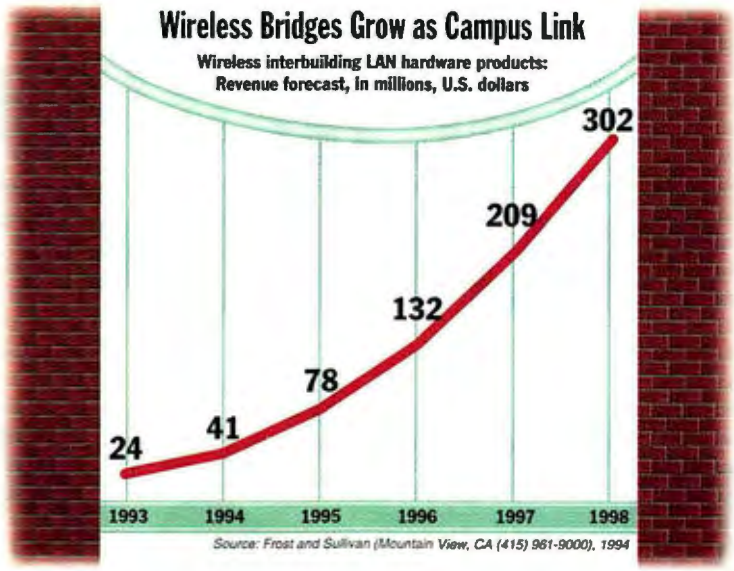
The four primary considerations when evaluating a complex database system are interoperability, affordability, adaptability, and scalability. Interoperability allows you to pick the best components—both hardware and software—and know that they will work well together. Adaptability guarantees the system will accommodate advances in technology. Affordability takes advantage of the plummeting prices in the personal computer and LAN markets. Scalability ensures the ability to add or reduce components to a system to adjust for changing business requirements. Scalability ensures that a database system will always meet your business needs. If your company downsizes, your database application downsizes with you. If your company grows, your system grows.

Microsoft takes Access one step further with an Upsizing Wizard that converts standalone database applications to an Access front-end and a Microsoft SQL Server back-end. In addition, a whole genre of products, such as Gupta's SQLWindows and Sybase's PowerBuilder, are designed specifically for scalable front-end development.

To implement front-end scalability, cross-vendor software solutions rely on standards, and standards typically lag behind technology. Both the SQL Access Group's SQL standard and Microsoft's vendor-neutral ODBC standard make it possible to develop applications using sophisticated database server software while taking advantage of the ease of use and relatively low cost of hardware and software on the personal computer platforms. The problem: To take advantage of nonstandard functionality (which typically includes vendor-specific features and recent innovations), the developer must sacrifice scalability. This is why many vendors refer to ODBC as the least-common-denominator approach. For example, neither the SQL Access Group nor ODBC take advantage of triggers or stored procedures.

Single-vendor front-end development (using front-end and back-end software from the same vendor) guarantees both language and API consistency. Though single-vendor solutions tend to rely on proprietary technologies, which creates a dependency on that vendor, these solutions let developers take full advantage of the vendor's extended feature set.

These homogenous solutions introduce one more exciting prospect for the PC database developer: the possibility of developing truly scalable database applications (not just front ends) on the PC. Gupta's continued development of SQLWindows, Sybase's purchase of Powersoft (publishers of PowerBuilder), and the release of the Personal Oracle7 products bode well for future scalability in PC database development.



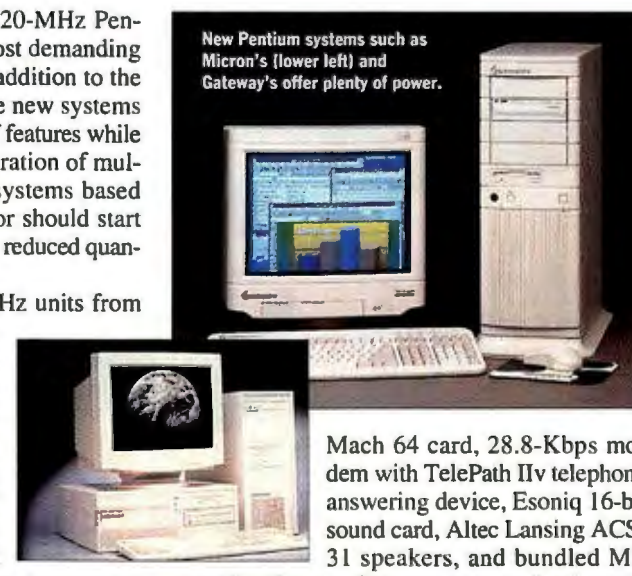
Frost and Sullivan expects businesses to increasingly turn to wireless bridges from companies like Solectek, Windata, Persoft, Proxim, and Cylink for building-to-building (aka campus) networking. Wireless bridges, unlike a frame relay or T1 link, don't require you to dig trenches to link two buildings.

Proxim (Mountain View, CA (415) 960-1630) recently introduced a line of low-cost wireless bridging solutions that range in price from $2975 to $3725 per antenna and offer throughput ranging from 500 Kbps to 1.2 Mbps. The initial install of a 1.5-Mbps T1 line can cost about $11,000, and customers must also pay monthly fees of about $300.

120-MHZ PENTIUM PCS

Pentium Dream Systems Arrive

PCs based on Intel's new 120-MHz Pentium should quench the most demanding power user's need for speed. In addition to the faster processor, the first of these new systems that BYTE tested offer a wealth of features while preparing users for the next generation of multimedia applications. The new systems based on the 3.3-V, 120-MHz processor should start shipping in April from vendors (in reduced quantities until June).


New Pentium systems such as Micron's (lower left) and Gateway's offer plenty of power.

BYTE looked at early 120-MHz units from Micron (Nampa, ID, (800) 233-7027 or (208) 463-3434) and Gateway 2000 (N. Sioux City, SD, (800) 846-2000 or (605) 232-2000). Both systems use Intel's Triton PCI chip set to support fast EDO (extended data out) memory (16 MB standard on both systems) and 256 KB of synchronous burst cache. This chip set also prepares the systems for future native signal processing applications (see BYTE's March 1995 issue, page 38).

Micron's P120 Millennia miniature tower case includes a Micronics motherboard and a 1.3-GB Conner IDE drive, quad-speed Enhanced IDE Sony CD-ROM drive, and bundled Microsoft software. The $3799 price also includes a 15-inch monitor, Diamond Stealth 2-MB VRAM graphics card, and SoundBlaster 16 audio card.

At $4299, Gateway 2000's P5-120 tower system includes luxuries like a 1.62-GB Western Digital IDE hard drive, a three-disc, quad-speed Sanyo CD-ROM drive, 17-inch Vivitron monitor, 2-MB VRAM ATI Mach 64 card, 28.8-Kbps modem with TelePath IIv telephone answering device, Esoniq 16-bit sound card, Altec Lansing ACS-31 speakers, and bundled Microsoft software. Gateway uses an Intel motherboard.

120-MHz Pentium systems' integer and floating-point benchmark results. (A 90-MHz Pentium Dell XPS/90 scores a 1.00 on both tests.)

	MICRON	GATEWAY
Integer	1.33	1.32
Floating Point	1.30	1.29

Running BYTE's Native-Mode benchmarks showed precisely what one would expect for a 120-MHz Pentium machine. On the integer test, the ratio of the scores to our baseline 90-MHz Dell system's score was 1.33 and 1.32, the same as the 120-to-90 ratio of clock speeds. The 120-MHz Pentium chip, which currently sells for $935, is 1.71 times the price of the 90-MHz Pentium ($546). However, power users will find much to like in these new systems; more patient users will likely wait for Intel to lower the price it charges system vendors for the new 120-MHz part.

—Rick Grehan

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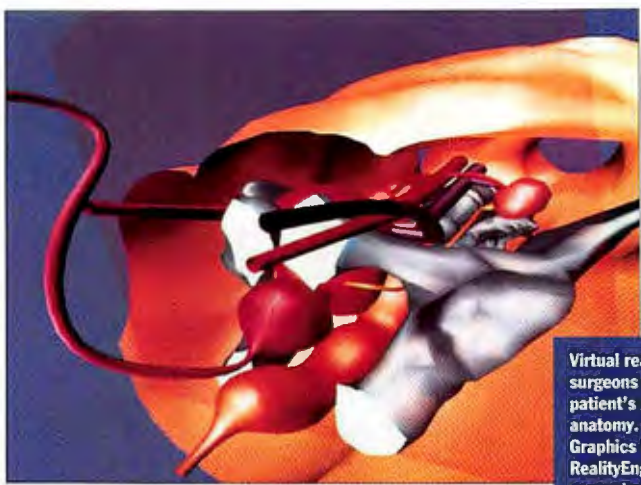
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VIRTUAL REALITY

VR Can Improve Your Health



Virtual reality can help surgeons preview a patient's internal anatomy. A Silicon Graphics Onyx RealityEngine2 generated this simulation in preparation for laparoscopic surgery.

Medical education and surgery professionals are using VR (virtual reality), a technology often associated with interactive, computer-generated graphics and immersive environments, to fundamentally alter and improve the way medical care is taught and delivered. Whether used for remote education or to improve surgical skills, VR is impacting a variety of medical disciplines.

One such discipline is the innovative medical procedure called laparoscopic (aka key hole) surgery. In this minimally invasive procedure, a doctor performs an operation by guiding an elongated surgical instrument through a tiny hole in the patient. Laparoscopic surgery can eliminate ugly postsurgical scars, but it is a difficult skill to perfect. To help doctors hone their skills, several companies are developing laparoscopic simulators.

These simulator systems typically feature a mannequin into which real laparoscopic instruments—or some other apparatus that operators can manipulate—are inserted. Surgeons look at a video monitor as they would in actual surgery but view a computer-generated anatomy instead of the real thing. As the surgeon maneuvers the instruments to cut, stitch, and perform other tasks, force feedback controls in the mannequin simulate such realistic responses as resistance to encounters with bone or bleeding from an incision.

Laparoscopic simulators are now being integrated into instructional training systems. At the third annual "Virtual Reality Meets Medicine" conference recently held in San Diego, companies such as Cine-Med (Woodbury, CT (203) 263-0006), Ethicon Endo-Surgery (Cincinnati, OH (513) 786-7000), and High Techsplanations (Rockville, MD (301) 984-3706) all described laparoscopic simulator systems that should be available for evaluation in teaching hospitals this year. These first-generation simulators will likely be used to teach residents basic laparoscopic skills and measure their performance. These systems can improve training in a safe and controlled environment.

Applications that simulate human response to medication can benefit other medical disciplines. For example, CAE Electronics, Inc. (Binghamton, NY (607) 721-4552) and Loral Data Systems (Sarasota, FL (813) 371-0811) sell life-like simulator systems to help train anesthesiologists. As with some laparoscopic simulators, these systems feature a fully instrumented mannequin that breathes and reacts just like a human patient. By creating this virtual patient environment, anesthesiologists can practice emergency techniques or rare event scenarios. Systems such as this are analogous to mature flight simulator systems used to train pilots.

In neurosurgery, new navigation and multimodality imaging tools can precisely guide surgical tools through brain tissue to the site of a tumor. A new stereotactic surgical microscope from Carl Zeiss (Thornwood, NY (914) 681-7768) can superimpose diagnostic images, such as MR (Magnetic Resonance) data, into the eyepiece of the microscope. This image corresponds exactly to the part of the brain on which the microscope is focused, letting the surgeon see the tissue in two modes. This helps detect the boundaries of the tumor, which are not always visible to the eye. By focusing the microscope forward, surgeons can zoom through the MR data to preview what they will encounter next. Precise navigation improves effectiveness and reduces trauma and damage.



A new stereotactic surgical microscope from Carl Zeiss (Thornwood, NY) can superimpose diagnostic images, such as MR (Magnetic Resonance) data, into the eyepiece of the microscope, thus helping surgeons detect the boundaries of a tumor, navigate precisely, and zoom through the MR data to preview what they will encounter next.

Virtual reality technology is also impacting an area called telemedicine, in which advanced telecommunication systems deliver medical care to remote sites. Dozens of states and organizations are working on demonstration systems, including ones devoted to telesurgery. While the military is funding most early development, researchers see civilian applications for rural emergency surgical care as well.

Prototype telemedicine systems feature two stations: one at which the surgeon sits and a remote station that manipulates instruments to actually perform the surgery. The system features a live 3-D video and audio link and a data channel that carries data to precisely mimic the surgical instrument's movements at the remote site. Developers have already demonstrated systems that can perform delicate surgical procedures.

Head-mounted displays are often more practical than monitors in surgery. They are typically the see-through type or the type that occlude only part of the surgeon's vision, as do bifocal glasses. Experts see these as a more natural interface for a new generation of 3-D endoscopes now coming to market. Such systems promise to help improve hand-eye coordination over the current 2-D laparoscopic environment.

—Chris Chinnock

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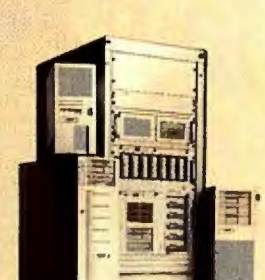
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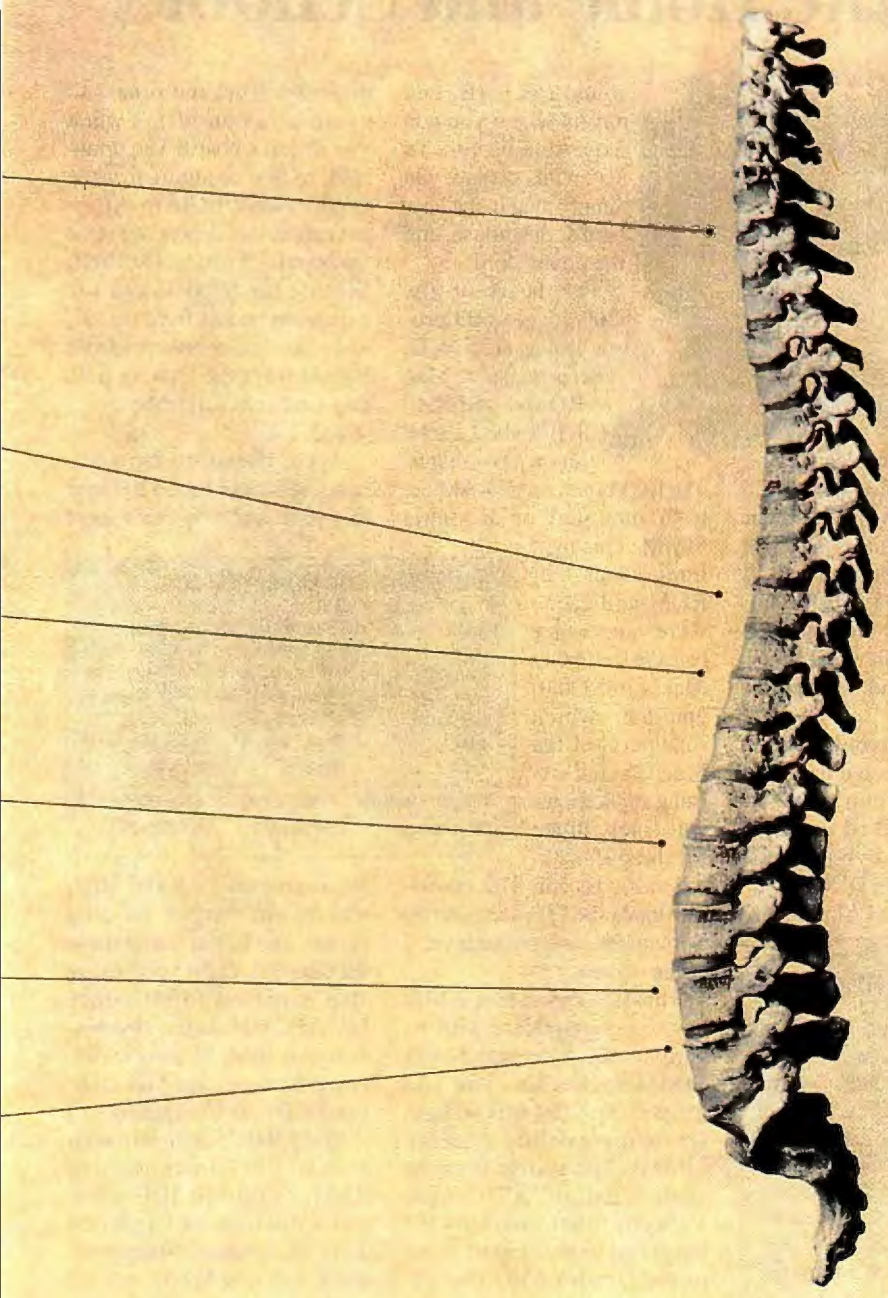


Fig. 1 Backbone

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POWER MAC 5200/75

RISC Invades the Home and School

Apple is driving RISC technology into the home and education markets with its new Power Mac 5200/75. The new system builds upon the LC line while offering more processing power and more features. The 5200/75 uses a PowerPC 603 RISC processor, which delivers roughly the same performance as the PowerPC 601 found in existing Power Macs, but at a lower cost and using less power. The 5200/75 also borrows hardware from the Quadra/Performa 630 to provide versatile multimedia capabilities.

Apple's line of LC Macs addresses the needs of the education market: They're inexpensive and feature a compact design. The latter is important in schools, because the LC's all-in-one design packs the monitor and computer into a single box, which eliminates setup and theft problems. At first glance, the system looks like a monitor on a tall swivel stand. But you'll also find stereo speakers, the floppy drive, and a CD-ROM drive on the monitor bezel. A closer examination reveals monitor control buttons (contrast and brightness), built-in microphone, and head-phone jacks.



The first PowerPC 603-based Mac offers a simple, clean design that's loaded with features.

When you pivot the monitor around, the usual gaggle of I/O ports come into view: one ADB (Apple Desktop Bus) port for the keyboard and mouse, two mini DIN-9 serial ports, a DB-25 SCSI port, two sound I/O ports, and covers where you add expansion boards. To set up this system, you simply plug in the keyboard, the mouse, and the power cord.

The heart of the 5200/75 is a 603 processor beating at 75 MHz. The processor, Mac ROMs, and 256-KB level 2 cache sit on a 64-bit bus. The ROMs and cache RAM are both mounted on a single SIMM. This tight integration of ROM and cache were necessary because the Power Mac's 68LC040 emulator, which runs parts of the Mac OS and existing applications, was finely tuned for the 601's 32-KB unified cache. This emulator floods the 603's smaller 8-KB caches, unless the level 2 cache is used.

The 5200/75 uses a 32-bit bus to communicate with its peripherals. A second 72-pin SIMM socket lets you add memory up to 64 MB without scrapping existing memory SIMMs. The system uses the same custom ASIC (the Valkyrie) that provides the integrated video support found in the Quadra 630. The 15-inch monitor has an on-the-fly adjustable resolution of 640 by 480 pixels or 832 by 624 pixels and supports maximum display depths of 16 or 8 bits, respectively.

For expansion, the 5200/75 has an LC PDS (processor direct slot), plus slots that accept video-in boards, a TV tuner, and a modem or Ethernet board. Each slot is physically different from the others to avoid setup problems when you install a board. The drawback to this design is that the vendors must build to different connectors depending upon the board's function. However, because the 5200/75 can use expansion boards from the LC, and video and communications boards from the Quadra 630, this problem might be overstated.

Apple intends to introduce faster versions of the 5200 later this year, and you can expect them to use the PowerPC 603e, which has larger on-chip caches and is pin-compatible with the 603. Other vendors are also expected to introduce PowerPC 603–based systems, including IBM, Motorola, FirePower Systems, and Mac clone vendor Power Computing.

The 5200/75 will ship with 8 MB of 70-nanosecond RAM, a 500-MB IDE drive, and a dual-speed CD-ROM drive as standard equipment, and it will cost $1699 in K-12 markets. A Performa version for the home markets is expected later this year and will include bundled software and a 14.4-Kbps modem. It will probably sell in the $2400 to $2500 range. Apple has already sold over 1 million Macs. With the 5200/75, the company is poised to bring RISC into the home.

—Tom Thompson

HIGH MARKS FOR EDUCATION MAC

BYTE's native RISC benchmarks indicate that on most tests, the new Power Mac 5200 is faster than a Power Mac 6100/60 system. The 5200/75 has a secondary cache, but the 6100/60 does not. The 5200/75 also uses improved floating-point libraries.

Index	Power Mac 5200/75	Power Mac 6100/60
Integer Average	.780632759	.635500506
FP Average	.585809155	.217984227

Compaq Reduces Cost of Ownership

The typical PC network costs about $2800 annually to manage per PC, according to the Gartner Group (Stamford, CT). The Desktop Management Task Force, a group of companies formed to help standardize and simplify PC network management, has raised awareness of this issue. Last year the DMTF released its DMI (Desktop Management Interface), but important elements are missing. Service layers, the intermediate software layers that manage access to the Management Information Files that hold software and hardware component data are available for DOS, Windows, and OS/2, but because they aren't embedded in the operating systems, they aren't ubiquitous. Also missing: a standard protocol to collect management information over the network and lots of DMI applications.

Compaq (Houston, TX (800) 345-1518) is making it easier for LAN management software vendors. The company implemented APIs in the ROM of its new Deskpros so that management applications can easily manage and troubleshoot the new PCs, their hard drives, and the latest Compaq monitors. Now numerous PC LAN management vendors can monitor the new PCs and access manufacturer, make, and serial number of compliant components. "The DMI service layer will become a great source of information for us once it is widely distributed," says Anne Gunn, vice president of Tally Systems (Hanover, NH (800) 262-3877), a vendor of asset management products and one of Compaq's many partners. "But Compaq is giving us a way to access its PCs now."

—Dave Andrews

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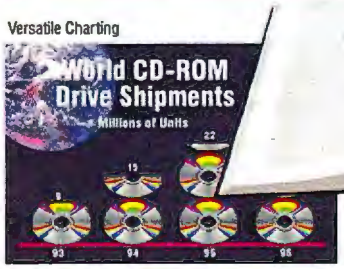
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New Back-UPS®: $119 blackouts, brownouts

Just don't have the time for power problems on your PC? Don't worry. They'll always make the time for you. It's not if a power problem will occur, but when. Due to household appliances, poor wiring, bad weather or even other office equipment, power problems are as inevitable as death and taxes. You can't run, but you can hide, behind APC protection.

That's why we've just introduced new models in our award-winning Back-UPS line, now delivering reliable protection for just $119.



Source: Contingency Planning



Source: Bell Laboratories

IN THE NEXT THREE MONTHS, MORE THAN 30,000,000 PCs WILL BE HIT BY POWER PROBLEMS...

Who needs power protection? If you use a computer, you do. A study in a recent *PCWeek* showed that the largest single cause of data loss is bad power, accounting for almost as much data loss as all other causes combined. Every PC plugged into an outlet is vulnerable. In fact, you have better odds of winning the lottery than of escaping the sting of power problems. One study found a typical PC is hit over 100 times a month, causing keyboard lockups, hard drive damage, and worse.

Simply put, if power problems are the least of your troubles, you've got one chance to keep it that way. You insure your car and home with the best policy you can afford. It just doesn't make sense to leave your PC (which is at far greater statistical risk) vulnerable to loss or damage.



WHY A $119 APC UPS COSTS LESS THAN A $9.99 "SURGE PROTECTOR"...

Contrary to most people's belief, a PC alone already has more protection built into it than a low-end "surge suppressor," which is usually nothing more than a well-packaged extension cord. In other words, going without any protection is just as good as underspending on one of the most important PC decisions you'll make.


For extended brownout protection for advanced PC workstations call about APC's New Back-UPS Pro!

And since sags and blackouts represent more than 90% of power problems likely to hit your computer, even quality, high-performance surge suppressors are literally powerless to protect you from data loss.

PC World Top 20 Upgrade — *"Don't take chances. Get the ultimate protection... from APC."* –PCWorld

"★★★★ *Back-UPS should be standard on every desktop... effective, affordable, designed to last..."* –PC Computing

"Never been cheaper or more convenient. A UPS can pay for itself the first time it saves your data." –MacUser

PC Magazine UK — *"The clear winner in price performance... it's unbeatable..."* –PC Magazine UK

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protection against and other trials by fire

More than 3,000,000 satisfied customers count on APC reliability that goes above and beyond the call of duty

After a raging fire which took 18 trucks to subdue, Michael Benolkin, director of the Systems Division at Correa Enterprises, Inc. didn't expect much. "While rummaging through the ashes, we heard something beeping. Our four APC units were still in action, while two UPSes from another brand were history. We're still using these same APC units at our new office location - they still work like a charm! We're impressed with the ruggedness, reliability, and product support offered by APC."



Trial by Fire

Brian Krause, Network Manager for Goodyear Airship Operations, knows how critical APC protection can be." The night of the All-star game a tornado came through our blimp hanger and took out our roof. Our airships demand absolute communication so I protect our local and remote servers with the most reliable protection I can find: APC. APC's PowerChute software shut our server down in an orderly way... closed out all files nice and neatly. When we reconnected, everything came back up perfectly, without a hitch."



Trial by Air

Doug Welch learns his reliability lessons well: "While still a Computer Science student, I was at home preparing a large spreadsheet for a final project when Anchorage experienced an all too common 5+ Richter earthquake. If not for my Back-UPS 400 it would have been back to square one! I'm now the Network Systems Manager at Charter College, in charge of three networks. I learned my UPS lesson well back in my student days. I've never been disappointed with APC and the product has had quite a work out."



Trial by Earth

Faced with a water main break, Mark Conley, Regional Manager of Novell's remote sales office in Detroit was amazed at APC's reliability. "The APC unit was sitting in an inch and a half of water, working just fine, as though nothing was unusual and we lost no data to this disaster. We've used APC here now for at least four years - more than a dozen units are all around the office, and we're well satisfied, so we were even more impressed to learn that the units are amphibious!"



Trial by Water



Back-UPS Award Winning FEATURES

- Unmatched surge/lightning protection for maximum hardware safety
- Site diagnostics automatically spot missing ground and reversed polarity
- LAN signaling allows simple shutdown with interface kits for automatic data protection (400 and above)
- User replaceable, hot swappable batteries insure uptime safe disposal. Batteries will last 3-5 years under normal use.
- $25,000 lifetime Equipment Protection
- 10 minute runtime with specified applications. For longer runtimes choose next largest unit.

Model	Application	Sugg.List
200 **NEW**	"Green" PCs	$119
280 **NEW**	LAN Nodes	$139
400	Desktop 486/386 systems	$199
450	Tower 486/386 systems	$254
600	CAD/CAM workstations	$359
900	Longer runtime	$529
1250	Multiple systems	$689

That's why you need instantaneous battery backup power from an APC Uninterruptible Power Supply to prevent keyboard lockups, data loss, and crashes. With an APC UPS, you get six times the protection of a high-end surge protector for little more than twice the price. And $119 is much less expensive than false piece of mind. APC UPSs carry up to a $25,000 lifetime guarantee against surge damage to your properly connected equipment, and are available to suit any application, from network servers and PCs, to fax and satellite systems.

PROTECT YOURSELF OR KICK YOURSELF...

It's been said that there are two types of computer users: those who have lost data, and those who are about to. Prevent the single largest cause of computer problems and join a fast-growing third category: those who protect their PC's with the most reliable protection they can buy: APC UPSes. So ask for APC at your favorite reseller. At just $119 an APC UPS is serious protection no serious computer user should be without.

APC has won more awards for reliability than all other UPS vendors combined...



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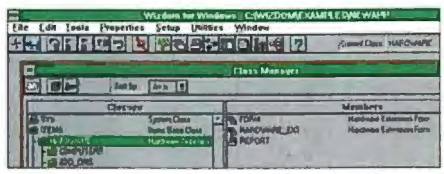
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INTERNATIONAL NEW PRODUCTS

BYTE Picks CeBIT's Best

HANNOVER, Germany—BYTE's editors honored innovative new products displayed at CeBIT '95, the world's largest technology exposition. BYTE's editors chose Wizdom Pro as the most significant new product at the show. BYTE's awards recognized new products developed in Europe and the Middle East. Exceptional products developed in the Far East were also recognized.

Wizdom Pro, from MLL Software & Computer Industries (Tel Aviv, Israel, 972-3-5656888; fax, 972-3-5613457) also won the Best Applications Development Software award. The Windows-based, Pascal-like tool lets you focus on the structure of your problem rather than on your application's user interface. The Scenic Media PC, from Siemens-Nixdorf (Augsburg, Germany, 49-821-804-3680; fax, 49-821-804-3600), a PC with a wealth of integrated communications, won the Best System award.



When you click the programmer subclass (at left), Wizdom displays all related (encapsulated) members at right. You can zoom in, view, and modify the definition of any member.

The Mobile Assistant, from Solid Computer (Oberschleasshaem, Germany, 49-89-31-57-19-0; fax, 49-89-3-15-91-46), won the Best Mobile System category. It integrates several communications and computing components into a mobile office and real-time route guidance tool for vehicles. The Gypsy Card MNP, from Dr. Neuhaus Telecommunication (Hamburg, Germany, 49-40-55-30-4-356; fax, 49-40-55-30-4-180), won for best peripheral. The PCMCIA type 2 device provides wireless communications by connecting to a wide range of phones that use the digital cellular GSM (Global System for Mobile Communications) network.

Taylor II 3.0, from F&H Simulation (Tilburg, the Netherlands, 31-13-366344; fax, 31-13-427516), which won the Best Applications Software award, is process modeling/analysis software that simulates the flow of objects within a process. Gig3Dgo, from Electrogig (Amsterdam, the Netherlands, 31-20-623-3495; fax, 31-20-622-6801) won in the Best Multimedia Software category for its SGI- and Sun-workstation-based 3-D modeling/animation software.

PCI Video board, from Fast Multimedia (Munich, Germany, 49-89-50-20-6-185; fax, 49-89-50-20-6-199) took the award as Best Multimedia Hardware. It packs a PCI (Peripheral Component Interconnect) graphics accelerator, a Windows video accelerator, a frame grabber, a TV tuner, and teletext capability onto an add-in card.

Cell-Master, an ATM (asynchronous transfer mode) multiplexer from CellWare (Berlin, Germany, 49-30-46-7082-0; fax, 49-30-46-307-658), took Best Hardware Connectivity honors. NM Elite, from Comtest (Kensington, London, England, 44-171-938-4591; fax, 44-171-938-1649), a program for analyzing and testing Ethernet LANs, won Best Connectivity Software.

BEST OF CEBIT FINALISTS

APPLICATIONS DEVELOPMENT SOFTWARE: Object Engineering Workbench for C++, from Innovative Software (Frankfurt am Main, Germany, 49 69-23-6929; fax, 49 69-23-6930), is a Windows-based software tool that offers object browsing, reverse engineering, program analysis, and relationship modeling. MetaEdit Plus, a Unix-based case tool, lets you design your business processes and information systems simultaneously using a wide variety of popular methodologies (from MetaCase Consulting, Jyväskylä, Finland, 358-41-650-400; fax, 358-41-650-120).

BEST SYSTEM: The N6-670 Suprema, from Olivetti (Ivrea, Italy, 39-125-2500; fax, 39-125-522524), is a 120-MHz, PCI-based Pentium system slated for commercial availability by the end of June. The Power 120 is a prototype 120-MHz, PowerPC 601-based system from Peacock (Wuenneberg-Haaren, Germany, 49-2957-790; fax, 49-2957-799291).

BEST MOBILE SYSTEM: Olivetti's Echos 48 Color Plus notebook computer. The Psion 3A hand-held computer, (the new 2-MB version) from Psion, (London, England, 44-171-262-5580; fax, 44-171-258-7340).

PERIPHERAL: PolyCon/XS Matrix Control Unit, from PolyCon Data Systems (Bielefeld, Germany, 49-521-9861321; fax, 49-521-9861322) eliminates duplicate monitors, keyboards, and mice by letting you control multiple network servers (up to 16 per unit) from one to four management consoles. The worldwide version of the Linalyzer from Bytecom (Dion-Valmont, Belgium, 32-10-223455; fax, 32-10-241730) is a device that analyzes and provides solutions to unpredictable power supply problems.

APPLICATIONS SOFTWARE: ZyFilter 3.0, from ZyLab Europe (Amsterdam, the Netherlands, 31-20-696-6277; fax 31-20-696-5175) lets your computer find the information you need from the Internet, fax, E-mail, or on-line news services. Run EDS, from Formula Systems (Nürnberg, Germany, 49-911-2879-115; fax, 49-911-2879-215) provides intuitive electronic schematic design and printed circuit board layout on six platforms.

MULTIMEDIA APPLICATIONS: Vidis 3.5, from SYM Media (Calderara di Reno, Italy, 39-51-728-728; fax, 39-51-728-730) is a Windows-based multimedia authoring program. The Treasures of Russia, from Intersoft (Moscow, Russia; fax, 7-095-278-6139) brings Russian art ranging from the Middle Ages to the avant-garde periods to CD-ROM.

MULTIMEDIA HARDWARE: miroVideo 12 PD, from miro Computer Products (Braunschweig, Germany, 49-53121-13-427; fax, 49-53121-13-159) combines affordable Windows graphics acceleration with full-screen AVI (Audio Visual Interleave) and MPEG playback. Play It, from Spea Software (Stamberg, Germany, 49-81-51-266-0; fax, 49-81-51-21258), is an inexpensive MPEG playback card.

CONNECTIVITY HARDWARE: OnLan, from RadVision (Tel Aviv, Israel, 972-3-647-6661; fax, 972-3-647-6669) lets you connect existing meeting room videoconferencing systems to LANs and routs videoconferencing traffic over LANs and WANs. Etherminal 4W from Igel (Augsburg, Germany, 49-821-7200-200; fax, 49-821-7200-199) is a secure multiprotocol terminal that supports Unix character, X Window applications, and Windows applications.

CONNECTIVITY SOFTWARE: PayDay, from Lagercrantz Communication (Sollentuna, Sweden, 46-8-626-06-50; fax, 46-8-754-77-59) is a network management program for studying network usage and billing back users or departments for support costs. NextInfo for Windows, from VoiceBit (Oulu, Finland, 358-81-537-2353; fax, 358-81-537-2338) simplifies the development of interactive voice response scripts and systems.

CEBIT '95 SPECIAL RECOGNITION AWARDS

- The 6Plex six-speed CD-ROM drive (transfer rates of up to 900 KBps), from Plextor (Tokyo, Japan).
- The Pentimedia II notebook computer (video, CD-ROM, stereo sound, 100-MHz Pentium), from Dual Enterprises (Taipei, Taiwan).
- The AcerNote 950 notebook computer (stereo sound, CD-ROM drive, active matrix display, 90-MHz Pentium), from Acer Computer (Taipei, Taiwan).

Mirror, mirror on the wall, who's the toughest of them all?



No question, it's the Tadpole P1000. Unlike other notebooks bound in plastic shells, the P1000 is the only one armored with a magnesium alloy case — making it highly durable, yet elegant and lightweight.

The P1000 is not only the toughest notebook on the block, it's the fastest too. With 100MHz of pure Pentium™ power, it could even outrun your desktop.

And with built-in features such as 256KB Level 2 write-back cache and a PCI bus for high-speed access to graphics, PCMCIA, and SCSI interfaces, the difference between the P1000 and other notebooks is knight and day.

Most important, the P1000 is tough enough to stand the test of time...it can be upgraded to reflect your needs in the future. Removable SCSI-2 hard-disk drives are available with capacities up to 810MB, memory is available up to 128MB of RAM using industry-standard SIMMS, and the Pentium processor can be factory-upgraded to tomorrow's even faster processors.

Between now and then, you'll appreciate the P1000's creature comforts. Its Lexmark keyboard with integral pointer and three mouse buttons fits your hand like a glove...and its 10.4" active-matrix TFT true color screen is easy on the eyes. And for presentations, the P1000 has 1MB of video RAM for fast graphics response, 16-bit CD-quality sound, and resolutions up to 1024 X 768 on external displays and projectors to slay even the toughest crowds.

The P1000 is the first notebook built to last. Call **1-800-232-6656** today for more information!

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INTERNET

Companies Cut Phone Bills

Corporations rely on their leased-line, private networks to cut their telecommunications charges by sending voice and data over these fixed-price-per-month circuits rather than over the public telephone network.

However, many companies can't reap the financial benefits of using leased lines because they don't have enough traffic to make them practical. And some companies save a fraction of the amount they could because they link large regional data centers but don't use dedicated lease lines to connect smaller regional offices.

Whatever the reason for not using leased lines, companies still pay phone charges every time someone in one site faxes or calls a person in another site.

Many companies already use the Internet to send data across the globe. Now companies are starting to use the Internet as a pseudoprivate backbone to carry fax and voice traffic between sites.

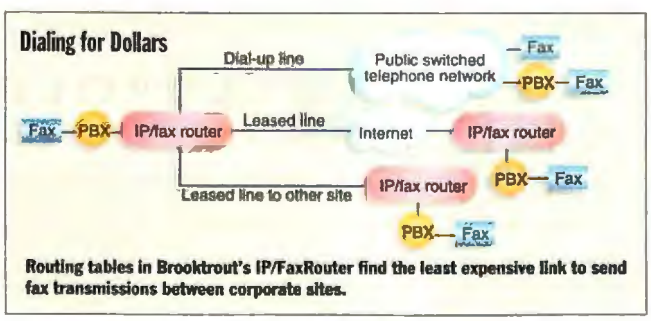
Helping things along in this area are new products from the Brooktrout Networks Group (Richardson, TX (214) 907-0885) and VocalTec (Northvale, NJ (201) 768-9400). Both companies already offered products that save telecommunications charges by running over private networks (see "Brooktrout Cuts the Cost of Internal Faxing," February BYTE). Their new offerings tap the Internet.

Brooktrout's IP/FaxRouter lets a company send a fax over the least expensive route: leased lines (when available), the Internet, or the public telephone network (see the figure), all the while retaining the simple-to-use interface of a common fax machine. The user simply dials the destination fax number, and the fax is transmitted over the least expensive link.

VocalTec's Internet Phone software uses three algorithms (one for compression, one that handles packets that arrive out of order, and one that smoothes out delivery based on Internet traffic loads) to let users hold phone conversations over the Internet. Each user requires a sound card, microphone (or telephone handset connected through the sound card) and a SLIP or PPP link into the Internet.

Phone conversations with Internet Phone are half-duplex, so only one person gets to speak at a time. The quality of the phone conversations is about that of a speaker phone, with some delays that make the conversations choppy. However, several users say this is acceptable, especially because they're saving the cost of a long distance phone call.

—Salvatore Salamone



Routing tables in Brooktrout's IP/FaxRouter find the least expensive link to send fax transmissions between corporate sites.

CODE TALK

RICK GREHAN

Toolbars To Go

I am always happy to see new ways of telling a computer what to do without resorting to manual programming. But I'm leery of development systems that don't let you code. I'm forever nervous they'll stall on the steep ascent of a critical programming task. SmartPad's Professional Edition from SoftBlox (Atlanta, GA (404) 892-0202) lets you work without code if you wish or with code if you must.

SmartPad is a Windows' development system for building toolbars. You can then install your homemade toolbars wherever you want: out on the desktop or inside an application.



SmartPad lets you build and install your own toolbars.

Of course, a toolbar is just a dialog with buttons, but SmartPad lets you build "smart" buttons. Tooltip-like titles you define automatically pop up a few seconds after you position your cursor over a button, and when you click on the right mouse button, balloon help appears. The toolbars themselves also have smarts: They reorder buttons when you resize them, and they let you move buttons around inside the toolbar or from one toolbar to another.

A SmartPad button can trigger one of seven actions. Probably the most common use is to launch an application. You can also program a button so that clicking on it touches off a series of keystrokes, activates a menu command, or even unleashes a macro that can be a mix of keyboard and/or mouse events. You can use SmartPad's macro recorder from the desktop or from within applications. Macros with lots of mouse movements can consume lots of memory. Thankfully, SoftBlox's recorder lets you selectively disable mouse events.

A SoftBlox button can activate a DDE and (pacifying my nervousness) execute SoftBlox's SmartScript program. SmartScript is a programming language that looks so much like Visual Basic that, if you're familiar with one, you'll have no problem with the other. You can build dialogs; perform user and file I/O; and in short, build your own suite of toolbar-activated miniapplications. Even better, you can use SmartScript as a vehicle for automating complex activities within existing applications. The price of SmartPad Professional Edition is $295, although as you read this, SoftBlox is selling it for a promotional $199. The standard edition (which does not include SmartScript) is $99.

Caution: It's easy to overdo toolbars, and SmartPad's simplicity makes that likely. Already I find myself swamped in active Excel toolbars, with little room left for the spreadsheet, and I haven't even *started* making SmartPad toolbars for Excel yet.

Looks like the whole world is getting Warped.

"OS/2® Warp is faster and prettier than ever before. It's reliable, and can give you 32-bit computing on your desktop today."

Personal Computer World, *December 1994* *(United Kingdom)*

"OS/2 Warp...brings advantages which give it a significant technical lead..."

The European, *October 14, 1994* *(Europe)*

"[OS/2] Warp is the natural upgrade for OS/2 for Windows™ users as it will run the latest versions of Microsoft®'s Windows software."

The Courier Mail, *October 18, 1994* *(Australia)*

"Fast, dependable, able to work better with fewer resources...a viable candidate for standard operating software for the multiplatform PCs of the future."

PC Windows, *September 1994* *(Italy)*



"With Windows 95 delayed...this is IBM's window of opportunity. OS/2 has always been technologically superior..."

Kevin Linfield, Computing Now! *December 1994* *(Canada)*

"IBM's OS/2 has quietly evolved from a DOS replacement to a corporate-class, scalable family of desktop and server solutions."

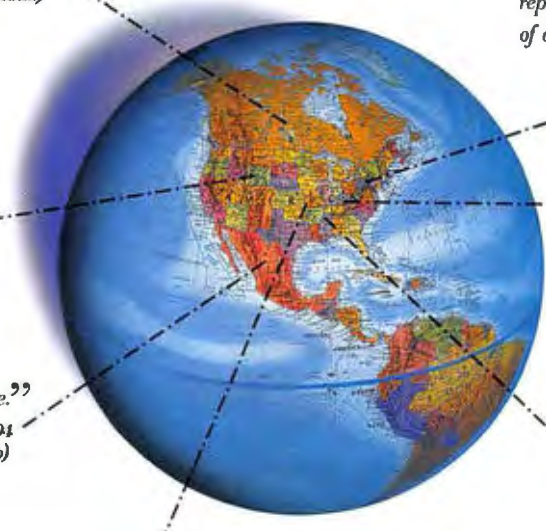
PC Week, *November 14, 1994* *(USA)*

"...no operating system product to date has offered as much out-of-the-box value as OS/2 Warp."

InfoWorld, *November 14, 1994* *(USA)*

"...it's obvious that IBM® has put a great deal of time and effort into making [OS/2] Warp a highly-optimized, easy-to-install, and easy-to-use operating system..."

Stan Miastkowski, BYTE Magazine, *November 1994* *(USA)*



"The wizard of OS/2... the main feature of this new version is that it requires less memory and it provides better performance."

InfoCHANNEL, *October 1994* *(Mexico)*

"My personal favorite—perhaps the most useful productivity software available today—is IBM's superior operating system, OS/2."

FORTUNE®, *March 6, 1995* *(USA)*

"OS/2 Warp will bring your system up to speed, hitting all cylinders by putting serious power under the hood."

Home Office Computing, *February 1995* *(USA)*



The 32-bit, multitasking, multimedia, Internet-accessed, crash-protected, Windows friendly, totally cool way to run your computer. **OS/2® WARP**

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Circle 170 on Inquiry Card.



[The 4.2-pound Liberty™ DX4-100 Best Buy features an impressive 10.4" screen, 720MB HD,

**Compaq® Elite™ and Toshiba™ Portege™ configuration, pricing and Ziff Davis' Winstone 95™ version 1.0 overall score are from January 24, 1995, PC Magazine. **Dell Latitude™ configuration and pricing are from March 1995, Windows Sources. Latitude Winstone 95 overall score is from January 24, 1995, PC Magazine. Compaq, Toshiba and Dell PCs use TFT displays. The Winstone 95 overall score for the Gateway 2000 Liberty DX4-100 Best Buy was achieved using a 100MHz Intel® 486DX4, 24MB, 256K L2 cache, 720MB HDD, local bus IDE, 64k disk cache, C&T 65545 1MB DRAM with C&T driver 3.11, MS-DOS 6.22 and Microsoft® Windows™ 3.11, SMARTDRV 2MB cache, and 640 x 480 pixels 256 colors. All products used in the test were shipping versions. The test was performed without independent verification by Ziff-Davis.*

How does this humble arthropod have the power to carry an object 50 times its own body weight?

It's like the Liberty small notebook from Gateway 2000. It may be small in size, but it packs a powerful punch that squishes the competition!



24MB RAM, 256K L2 Cache, 14.4 fax/modem, IR abilities and MS Office Professional for $4,499]

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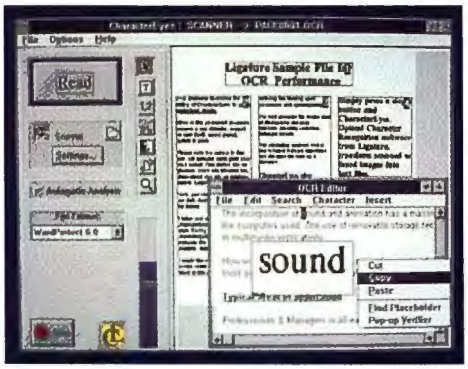
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IMAGE ACQUISITION TRENDS

OCR Fuels Slow Paper Burn



Programs like Ligature Software's CharacterEyes for Windows that integrate with other Windows applications and offer one-button scanning and improved accuracy are bringing the elusive paperless office closer to reality.

An OCR scanner—when combined with a fax/modem-equipped computer, software, and a printer—could soon be replacing stand-alone fax or multifunction fax-copier machines in the business office. "It really is a hot time for image acquisition, including scanners and scanning software," says Kristy Holch, director of scanning market strategies for market-analyst firm BIS Strategic Decisions (Norwell, MA).

Flat-bed, sheet-fed, and hand scanners are becoming more affordable. "Today, you can get a 24-bit, 300- by 600-dpi flatbed scanner for under $600," Holch says. That's about $200 below what most comparable units cost last year. Primax (Campbell, CA) has developed a combination hand-held/motorized/sheet-fed 24-bit scanner for Windows called the ColorMobile Office, which sells for $329. By June, the company expects to release an 8-bit, black-and-white hand scanner that will sell for just $89. Flatbed 8-bit scanners are also available for about $400.

The improved accuracy, usability, and ability to integrate with other core productivity programs of OCR software from companies like Xerox, Caere, and Ligature is also pushing demand for scanner solutions. OCR programs can still have problems correctly identifying small text in a smudgy fax. But software developers continue to improve the accuracy of programs in converting bit-map images into editable text using such technology as neural-network-based recognition engines.

The scanner/PC/modem solution won't appeal to everyone. Organizations who need to fax many documents—some paper-based and others PC-based—may prefer the combination of a fax machine connected to a network via an RS-232 serial port and a software fax server from a company such as LANsource Technologies (Toronto, Canada, (416) 535-3555). And magazines and other businesses are exploiting electronic distribution channels like the World Wide Web and E-mail for content publication instead of fax.

However, the move toward electronic distribution should increase demand for OCR and scanners. Many companies who have "legacy" documents (paper documents whose creating file is lost or not easily accessible) will need a bridge between the paper world and the electronic world. Building that bridge using OCR is getting easier and less expensive.

—Dave Andrews

NEW OCR PRODUCTS AT A GLANCE

TextBridge 3.0 ($99) and TextBridge Pro 3.0 ($349). These new versions of Windows OCR program offer improved accuracy. Pro version integrates with other applications, and its document recomposition preserves elements like document headers and footers within word processor or other applications. Power Mac versions are slated for later this year. Xerox Imaging Systems (508) 977-2000.

Primax Scanners Primax sells a range of portable scanners (see What's New, page 204). Primax (408) 364-2800.

PaperPort 2.0 for Windows (See What's New, page 203). Visioneer (415) 812-6400.

Delrina WinFax bundle (under $350) This package will bundle WinFax Pro for Wirdows with 300-dpi, multi-sheet-fed scanner from Fujitsu that connects to PC via parallel port. Delrina (408) 363-2345.

WordScan Plus 4.0 for Windows ($595) This new version of an OCR package from Caere has a new engine with improved text recognition. The company also sells OmniPage Pro 5.0 for Windows and Power Mac ($695) and PageKeeper document management/OCR software. Caere (408) 395-7000.

CharacterEyes for Windows 2.5 ($79.95) and Pro version ($495) The low-end version runs in systems with 4 MB of RAM. Pro version offers advanced deskewing (up to 20 degrees), support for Western European languages, trainable mode to read calligraphy and Greek letters. The Mac 680X0 version is to ship in May. Ligature (617) 238-6734.

Whatever Happened to . . .

Motif (see "Motif Offers Variation on LCD Theme," April 1994 News and Views).

About a year ago, BYTE wrote about Motif's active-addressing display technology that would offer active matrix quality at prices slightly higher than passive matrix displays. But in what analysts see as a setback to U.S. efforts to establish a domestic flat-panel display manufacturing base, the Wilsonville, OR–based company recently announced it has shut down its newly built LCD manufacturing line.

Motif vice president Kevin Cornelius says the company still plans to supply the ASICs its partners need to implement active addressing in their LCDs. Motif's partners include Tottori Sanyo (Tokyo, Japan), Standish Industries (Lake Mills, WI), Kyocera (Kyoto, Japan), and Asahi/Optrex (Tokyo, Japan). "We mothballed the front end of our manufacturing process because additional investment was needed to bring manufacturing yields up to competitive levels," Cornelius says. "A captive manufacturing facility is just not needed."

Motif says it will continue to assemble panels obtained from its strategic partners into final products. Motorola will manufacture the ASICs, and first-generation samples were due out this spring. Active-addressed products are expected to cost about 30 percent more than comparable passive matrix products. Second-generation ASICs are now under development, which should reduce the price premium over passive matrix to about 25 percent. **—Chris Chinnock**

Blasts from the Past

DENNIS BARKER



The new Amiga 3000 had a 68030, a 32-bit architecture, a multitasking OS, and a new GUI. It had a high-resolution display. It had stereo sound and connectors for video gear. It was "the ideal multimedia platform." It cost about half as much as a comparable Mac IIci. It had zealous owners. It had everything but big sales.

Intel's new 33-MHz 486 fueled **ALR's PowerVEISA** and **AST's Premium**, both screamers, but our review found that ALR's 64-KB external cache gave it more vroom.

Can you hear it huffing and puffing? Everybody was doing aerobics back then—including batteries. We reported on a zinc battery that breathed airborne oxygen and mixed it with water molecules in an alkaline gel electrolyte, which produced hydrogen atoms, which ... well, eventually it all generated electricity. Since our article, the Aerobic Power battery has been commercialized by AER Energy Resources. It's being used in power packs for handheld computers in vertical applications, and there are versions in the works for notebooks, including the Zenith Noteflex. "Zinc air batteries increase your run time by about five times," an AER spokesman said.





AT&T's Unix PC was the company's attempt to get Unix into the mainstream office. They were going to make Unix easier to use, see. The system came with menu-driven software that stepped you through most operations. It also featured two things novel enough to get italics: *virtual memory* and *telephony*.

Multiprocessing was the theme. We spent nine pages debating what it is—"it may mean two independent Z80 computers sharing only the same hard disk, [or] it may mean 2 million 68000s sharing everything from resources to the same program"—then concluded that most micro users don't need it.

Two now-legendary PCs came in for review that month: the new **Compaq Deskpro** and the new **IBM AT**. The Deskpro had a dual-speed 8086. For pure PC compatibility, you had to run at 4.77 MHz to emulate the PC's 8088. If you preferred speed, you could switch into 7.14-MHz mode.

Quiz Show

The object at right is ...

a. a cubist sculpture of a fried egg
b. a prop from *Star Wars*
c. the head of a cybernautic cyclops
d. an alternative input device, circa 1990

The AT trumped the PC, the XT, and a million clones by having the new 286 chip. This meant faster clock speed (6 MHz), a 16-bit data bus, and protected mode. IBM also added a new floppy format: 1.2 MB. But there was one thing the AT couldn't do that the Deskpro could: run Flight Simulator.



Desktop revolution Our West Coast bureau described a new program from a company called Aldus. The program was called PageMaker. People would use it to do something called "desktop publishing."

> "After all, how many processors do you need to move a paragraph?"

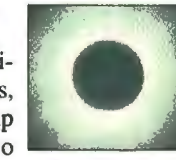
Jerry Pournelle gave his Folly of the Year Award to execs at two companies threatening new copy-protection schemes. One would plant malfunction-inducing worms in the PC. The other promised "booby traps that will make Vietnam look like a birthday party."

Smalltalk fans finally had some microcomputer versions to use: Digitalk's Methods, for the IBM PC, and Smalltalk-PC, for the Apple II. Wrote Bruce Webster: "Perhaps now that some 'real' Smalltalk implementations are reaching the micro market, the object-oriented approach to software development will get its first true test."



Floppy drives were exotic and expensive. We explained how to build a disk-controller board so you could hook a Shugart drive to your 8080A box.

You could stick with **cassette tapes.** "Floppy disks may be a glamorous way to store programs and data," one author wrote, "but the cassette is far from dead." Not only far from dead, but "here to stay." Like that parrot in the *Monty Python* skit, cassette storage must be merely resting.



Baked Apple Editor Carl Helmers, in Kenya, set up his Apple II to control a camera for photographing the solar eclipse. But it kept crashing. It was too hot. The sun had cooked the main board to about 180°F.

Return to sender A new report predicted that $4 billion would be spent on E-mail services and equipment by 1990. "The field will be dominated by IBM, AT&T, and GT&E, with the U.S. Postal Service getting about one-quarter of the business."

Price Check

Apple II, with 16 KB of RAM	$959
TI-99/4, with 16KB of RAM and a color monitor	$979
Micropolis MetaFloppy drive, with controller	$999
Altos 4-user system, with 29-MB Winchester drive	$14,260
Microsoft BASIC Compiler	$395
An Introduction to Microcomputers by Adam Osborne	$12.50

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PC Week called **Layout** a "sure thing." We call it a revolution. With over 200,000 users, tons of add-ons, and widespread third-party support, Layout is the only tool that lets you build DOS or Windows programs by manipulating objects on screen — without writing code. Not just simple programs, but real, heavy-duty, mission-critical applications.

The True Power of Objects

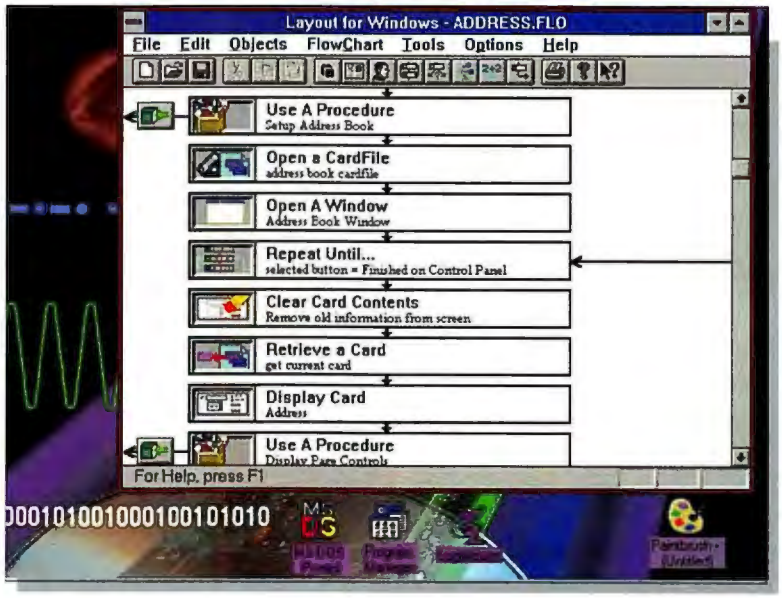
Layout is truly object-oriented, both in the programs it creates, and in how you use it. You start out by arranging objects in a simple diagram, and then add more objects as the program grows, or create new objects by combining existing ones. You can even run your program as you're building it. Data-entry, database, and report formats are all visually designed on-screen.

What Layout Delivers

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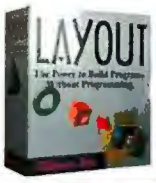
Visual Power, Incredible Performance

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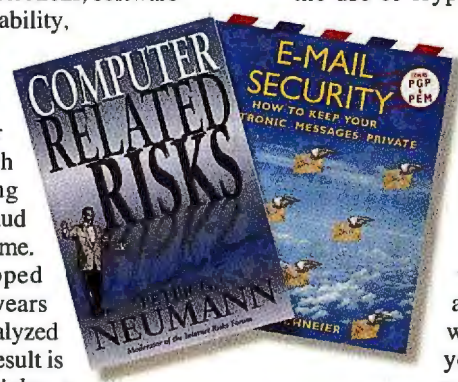
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Risky Business and Private E-Mail

RUSSELL KAY

For as long as I've dealt with the Internet, the single resource I've admired most is the Risks forum, or to give it its full name, Forum on Risks to the Public in Computers and Related Systems. This is a discussion group moderated by Peter G. Neumann, principal scientist at SRI International's Computer Science Laboratory.

Since Neumann started the Risks forum in 1985, it has provided a continuing stream of information and anecdotes about a remarkable variety of dangers and vulnerabilities that grow out of computer technologies. Among the critical issues discussed on Risks are privacy and legal protections, software and hardware bugs, reliability, inflated expectations of computer accuracy and trustworthiness, use of computer systems for what are life-and-death situations, and ongoing problems involving fraud and computer-related crime.



Neumann has stepped back, looked over 10 years of Risks digests, and analyzed what it all means. The result is *Computer-Related Risks*, a book that gave me a new appreciation for many threats that I'd known about, but whose implications I didn't fully understand. One of the most interesting chapters focuses on reliability and safety issues in areas ranging from nuclear power plants to medical monitoring systems and the consequences of our general dependence on computer-based clocks and calendars.

The first part of the book lists and comments on past problems, and the second part presents techniques for increasing system reliability and security. In addition, Neumann offers some blunt commentary on most peoples' unquestioning trust in computer-generated data.

My only quibble with *Computer-Related Risks* is that it is too analytical. It doesn't capture the wonderful give-and-take that appears on the Risks forum itself. On-line, you have the immediacy of informed and intelligent people talking to one another about the foibles and flaws—fatal, frivolous, or funny—of our increasing dependence on computers.

As more of our communication moves to E-mail, keeping it from the preying eyes of spies, crackers, and other assorted bad guys becomes more important than ever. Bruce Schneier's latest book, *E-Mail Security: How to Keep Your Electronic Messages Private*, tells you how to protect your correspondence.

Schneier is a security consultant who specializes in the black art/science of cryptography. His previous book, *Applied Cryptography: Protocols, Algorithms, and Source Code in C* (reviewed in the June 1994 BYTE), is a lucid yet detailed explanation of some of the esoteric aspects and implementations of crypto systems in current use. Thus, it's no surprise that his new book concentrates on the use of crypto systems to protect E-mail.

If you decide to encrypt your E-mail—or part of it—you need to be aware of a number of issues: key management (i.e., getting secret decryption keys to the people you want to have them) and administration (e.g., what happens if you lose your key?), third-party certification, digital signatures, and more. Schneier touches on these technical concerns, along with mechanisms for achieving them, such as one-way secure hashing, in a readable fashion.

A significant part of this book focuses on PGP (Pretty Good Privacy), the most widely used crypto system around the Internet, and PEM (Privacy Enhanced Mail), another popular crypto standard. The author discusses their strengths and weaknesses, points out their differences, and mentions why you might prefer one over the other (and which one, of course). In brief, PEM is largely concerned with authentication—you can't send an unauthenticated PEM message, for example—while PGP is much more concerned with protecting message privacy.

In addition to the main discussions of

COMPUTER-RELATED RISKS

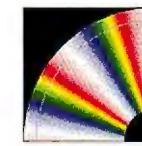
Peter G. Neumann
Addison-Wesley
ISBN 0-201-55805-X

$22.95

E-MAIL SECURITY: HOW TO KEEP YOUR ELECTRONIC MESSAGES PRIVATE

Bruce Schneier
John Wiley & Sons
ISBN 0-471-05318-X

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For today's travelers, Let's Go: The Budget Guide to Europe, based on the best-selling book, packs a great deal of useful information into an accessible format. To whet your appetite for travel, more than 100 pictures and 20 minutes of full-motion video show you the beauty of Europe. You can print topographic and transportation maps, estimate your travel times, and create an exciting itinerary, albeit one that will cost you more than $5 a day.

Based on college students' research, there are practical recommendations of places to see, ethnic restaurants that you shouldn't miss, budget-priced hostels, where to go for medical help, what to do if you lose your passport, and where to go (and especially where *not* to go) after dark. And, yes, there's even a list of clubs where you can score some hash in Amsterdam.

Forward to sometime in the future: I can just see my kids telling their grandchildren about the "good old days," how they saw Europe on only $200 a day. What a bargain!

—Rich Friedman

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the systems, two extensive appendixes detail how you can obtain and install these programs. For PEM, we get detailed design specifications. Schneier describes the munitions/export-restriction and patent/licensing rights controversies that have erupted over PGP and its creator, Philip Zimmermann. He includes Zimmermann's PGP user's guide, which by itself constitutes a "pretty good" introduction to crypto methods and issues.

Risky On-Line Reading

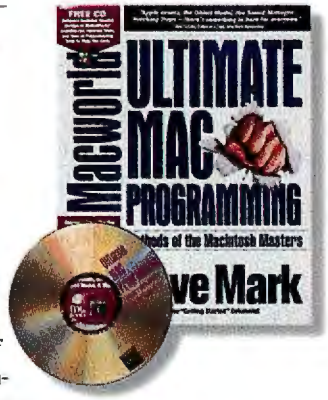
To access the on-line Risks forum directly, check your local system or on-line service to see if they already carry it. For example, Risks is available on BIX in the security/risks conference, and it's distributed on the Usenet as comp.risks. Past issues of the Risks forum are available for anonymous ftp from unix.sri.com in the /risks directory.

None of this material is particularly new. What makes this book noteworthy is the practical, down-to-earth way in which the author shows how to use these systems to enclose your electronic communications safely inside digital envelopes. ■

Russell Kay, a BYTE technical editor, has been reporting on computer security issues since 1981.

MAC PROGRAMMING REVEALED

ULTIMATE MAC PROGRAMMING
by Dave Mark IDG Books, ISBN 1-56884-195-7, $39.95



I firmly believe one reason the Mac hasn't garnered a greater market share is because of the paucity of books on how to program it. The number of authors providing solid Mac programming information can be numbered on one hand: Scott Knaster, Stephen Chernicoff, and Dave Mark. I bought all their works. I especially liked Mark's *Learn C on the Macintosh* volumes, which show you how to access the MacToolbox using the C language—not a minor task with the Toolbox oriented around Pascal.

Now Mark is back, bringing with him the expertise of numerous Mac programming wizards, such as Donald Olson, a member of Apple's OpenDoc team; Jim Reekes, who wrote the Sound Manager for System 7; Greg Anderson, who wrote the Scriptable Finder; and many others. Their expertise is consolidated in a 500-page tome appropriately titled *Ultimate Mac Programming*.

There's no introductory material here. You jump straight into a chapter on the Sound Manager and are taught how to add sound capabilities to an application. Another chapter details how to patch the Mac OS, with good treatment on writing "fat" (i.e., native PowerPC) traps. There's also an example of how to play a QuickTime movie, plus other practical odds and ends. The source code for these examples and a demonstration version of the Metrowerks C compiler is packed on a CD-ROM that's bundled with the book. I learned a lot from the book and highly recommend it. ■

—Tom Thompson

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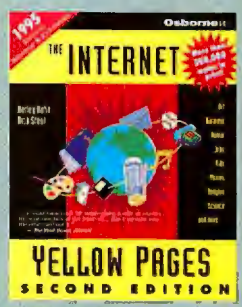
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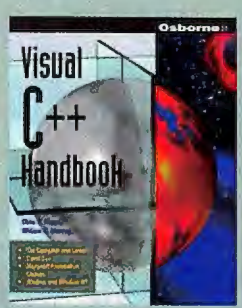
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Cover Story

YOUR NEXT MAINFRAME



PCs are getting to be as powerful as mainframes, and mainframes are being made from PC parts. But the mainframe of the future won't be a gigantic PC: It will be software and a network.

ANDY REINHARDT

PC users may be glad the glass house has shattered, but many of them are walking around with bloody feet. Some are even longing for the good old days of centralized, secure data processing. But while IBM mainframes are indefensibly expensive in this era of cheap microprocessors, centralization of data and applications isn't dead, and in some quarters, it's on the rise.

That's the dichotomy organizations face as they test the waters of client/server computing and experience the frustrations (and cost) of implementing new technology. In doing so, they are rediscovering the vaunted attributes of mainframes: security, reliability, data integrity, and a single system image for users.

Yet, no matter how robust and powerful PCs might become, they will never be mainframes in the traditional sense. "The PC is growing up to be an application server, not a mainframe," says Bob Robinson, product marketing manager for Sequent Computer Systems (Beaverton, OR). In other words, PCs aren't so much *becoming* mainframes as they are assuming the *responsibilities* of mainframes. To meet this challenge, they're borrowing the best of what host systems offer while throwing out the drawbacks of the old model.

And as PCs become more like mainframes—through improved performance, availability, and manageability—mainframes are getting to be more like PCs. Makers of big iron are cobbling together massive multiprocessor systems out of the same chips and disks used in desktop systems.

"The hardware components of the low end will end up being the building blocks of high-end systems, and the robust features at the high end will be implemented at the low end," says Phil Hester, general manager for system technology and architecture at IBM in Austin, Texas.

In fact, most observers expect the predominant system architecture of the future to be a hybrid model, where a variety of systems, ranging from desktop systems to servers to legacy hosts, are tied together under a common umbrella. "Some things really have to be centralized, whereas others are better distributed," says Shahin Kahn, who is marketing programs manager for Cray Research Superservers (Beaverton, OR). "It's a question of where you pay: a more expensive server or higher system administration costs."

System Scenarios

This blurring of computer architectures is erasing the relevance of terms like *mainframe*, *minicomputer*, and *microcomputer*. Computers of the future will instead be arrayed along a spectrum of functionality, driven by the roles they play. Vital corporate assets will be stored on giant secure servers. High-volume transaction processing will occur on optimized parallel processors. Routine file, print, and communications services will migrate to specialized nodes that could just as easily be embedded processors as PCs.

Centralized Systems	Distributed Systems
PROS	PROS
Better security	Lower-cost hardware
Lower support costs	Distributed fault tolerance
Fault tolerance	Faster access to local data
Easier data management	Reduced communications costs
CONS	CONS
More expensive hardware	Harder to manage

At least that's one scenario. It's also possible that hardware differentiation will become a thing of the past. Replacing special-purpose servers could be vast webs of commodity computing boxes, whose functions and interrelationships will be entirely configured in software. In this vision, the top of the computer food chain is a so-called *virtual mainframe*, comprised of an arbitrary number of conjoined nodes that perform what we now call mission-critical or enterprise functions. Only at the periphery of the network might the computers be optimized, perhaps for different user interfaces (e.g., office automation, communications, or home entertainment) or usage patterns (e.g., stationary versus mobile).

"Virtual mainframes deliver to people the ability to concentrate computing horsepower very flexibly, when and where they need it," says Joe Firmage, vice president of strategic planning at Novell (Provo, UT). "You can move power around the organization at will." The challenge, of course, is to invest network software with the ability to emulate high-end mainframe features—within the considerably more dynamic, unpredictable, and complex world of distributed computing.

Different Roles

Today, there are two distinct definitions for a *mainframe*: a hardware/software platform for running legacy applications, or a set of high-end capabilities that may or may not require using a machine known as a mainframe. The latter model is at the heart of downsizing. Customers are looking for less expensive alternatives to traditional host systems for new (and sometimes existing) applications, but they aren't willing to give up mainframe-class performance and features. "What we really want," says Alice Middleton, a vice president and IS manager for Bank of America (San Francisco, CA), "is a computing environment that offers us the richness and flexibility of GUIs at the front end, with the security and reliability of a mainframe at the center."

Carl Amdahl, CEO and chief technical officer of superserver maker NetFrame Systems (Milpitas, CA), defines mainframes in terms of customer needs rather than technology. "We're talking about bet-your-business applications," he says, citing organizations that cannot operate if their systems fail, that will suffer grave economic impact from downtime, or that must be able to maintain and grow systems while they're running. "These needs have classically driven the design of mainframes," Amdahl says.

At a minimum, mainframes are designed to provide hundreds of MIPS of processing capacity, gigabytes or terabytes of storage, and high I/O bandwidth (via hundreds of parallel DMA channels) to support large data sets and many users. They typically use extensive memory buffers, dedicated I/O controllers, intelligent queuing, and path management to boost performance, says Rick Baum,

PHOTOGRAPHY: ED JUDICE © 1995

an IBM Fellow and vice president of system architecture and performance.

Features built in to support reliability, availability, and serviceability (often called RAS) include redundancy of key components, error-correcting memory, diagnostics, hot-swappable components, and *service processors* that monitor performance, correct problems, and notify operators of alarm conditions. Software tools play equally vital roles: backup, HSM (hierarchical storage management), security, user/account management, predictive diagnostics, asset management, capacity planning, and cost accounting.

The decline of the traditional mainframe is occurring not because users no longer need these capabilities, but because it has an untenable cost structure and outmoded software model. New IBM mainframes this year will cost on average $39,000 per MIPS, including software and service, estimates Annex Research (Phoenix, AZ). That compares to roughly $20 per MIPS for x86-based PC hardware. But, quips Annex president Bob Djurdjevic, "a MIPS is not a MIPS" when comparing PCs and mainframes. For one thing, the perceived price of PCs greatly underestimates the cost to manage them (which some analysts peg at $8000 per year per seat).

The problem with mainframe software goes beyond its notorious expense and inflexibility: Mainframes use a shared-logic model, in which applications run at the center and are accessed via dumb terminals. This model no longer makes sense when inexpensive microprocessors let you off-load from the host both the user interface and applications processing.

Thus, the role of traditional host systems is changing. "The mainframe today is not a computer that provides processing power for the whole company," says Pauline Lo Alker, president and CEO of Network Peripherals (Milpitas, CA). Instead, it's a server or data repository. IBM is promoting the use of its mainframes as giant video servers for the information highway, and third-party products (e.g., Proginet's LAN-Fusion) are simplifying integration of mainframes into PC LAN environments.

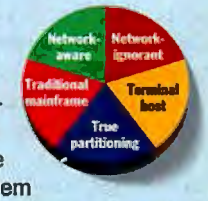
Why use a mainframe? IBM's William Hoke, vice president of worldwide PC Server development and a veteran of the company's mainframe era, reaches for an answer. "The world is run by applications, not hardware," he asserts. Mainframes are supported by a wealth of software and tools; it's this legacy that is their greatest—and soon perhaps only—asset.

Hybrid Model

Traditional mainframe functions are now appearing on a variety of systems. One of the most widely used hybrid architectures today, says Gary Bloom, vice president of the mainframe and integration technologies division at Oracle (Redwood Shores, CA), is a three-layer hierarchy. It consists of desktop PCs (connected via NetWare or another NOS [network operating system] for file and print sharing, as well as some network applications), a mainframe at the center (accessed via 3270 emulation for legacy applications), and a middle layer of Unix-based database and application servers. The servers run new programs and may also access the mainframe as a shared, secure data repository.

The key to this model is that it uses each platform for what it does best. PCs deliver the lowest cost and broadest software base for clients, and they let users create their own solutions. Large Unix servers run circles around PCs in terms of performance and the number of enterprise-class applications, yet they're far more cost-effective than mainframes and support new

Five Software Models



One way to view the difference between classes of computers is by the software they run. Joe Firmage of Novell splits the pie into five pieces. The first category is network-ignorant desktop programs that gain access to shared resources only because a redirector inserted below them diverts file and print I/O calls to remote systems.

The second category is network-aware applications designed specifically for LANs (i.e., groupware, SQL query tools, and custom-designed PowerBuilder front ends) that take advantage of a data repository across the wire. These applications typically use limited server-based processes, such as triggers and stored procedures.

Firmage calls the third category true partitioning. In this model, client and server components are independent and fully programmable, each with a known interface. "The transition in the PC world from local database applications to client/server applications will be matched by as big a step from client/server to partitioned," he predicts.

In the fourth category, work load shifts more to the server. The client executes only a simple component that accesses a centralized service via an API. This model more closely resembles a conventional terminal/host architecture, except that greater intelligence is assumed at the client. Compared with the third category, the server-based approach can reduce network traffic.

The fifth category maps most closely to a traditional mainframe, because there is no active client-side component at all. The user is merely represented inside the central machine by a daemon. An essential foundation of these kinds of centralized programs is a multiuser OS that supports remote log-ins from numerous terminals.

Firmage believes the computer industry is headed toward the third category. "The partitioned scenario is the midpoint of a convergence between the PC and mainframe model," he says, because it incorporates aspects of both distributed desktops and traditional shared logic.

Client and Server in One Box

One intriguing implementation of partitioning is a scheme called *client/client/server*, in which the true client (i.e., the end user) is represented inside the server by a client process, or proxy. This arrangement can reduce network traffic and boost performance, because both the proxy and server operate within the same machine and communicate at bus speeds rather than network speeds.

This scheme breaks the hard coupling between the front and back ends (which in traditional client/server requires a hard-wired, real-time, RPC [remote procedure call] protocol) in favor of a more flexible, asynchronous link, based on RPCs or lighter-weight messaging. Using proxies will make it easier to implement transparent or dynamic networks, because the communications protocol between the client and proxy can vary depending on the network, even while that between the proxy and server remains fixed.

software not available for hosts. Mainframes provide top-of-the-line I/O performance, security, and manageability for central data.

But as PCs and Unix systems become more sophisticated—as the capabilities of systems converge—this three-tier model could fold into two layers, or even one. The trend began several years ago with the introduction of superservers from companies such as NetFrame and Tricord (Plymouth, MN). Now it is accelerating into the fast-growing segment of commodity servers from AST (Irvine, CA), Compaq (Houston, TX), Dell (Austin, TX), Digital Equipment (Maynard, MA), Gateway 2000 (North Sioux City, SD), Hewlett-Packard (Palo Alto, CA), and IBM (Somers, NY).

Your Next Mainframe?
ClusterServer 8500
NetFrame Systems



The NetFrame's clustered architecture scales up to 12-100 MHz Pentium processors, including a two- or four-way SMP complex. It supports up to 2 GB of shared memory and more than 500 GB of storage on 120 disk drives.

There's no hard-and-fast definition of servers versus superservers. A common rule of thumb in the past was that servers were uniprocessors that were used mostly for NetWare. Superservers were multiprocessors meant for databases and other client/server applications. However, multiprocessing and more robust OSes are starting to appear in lower-end systems, so the differentiation is becoming murky. Suffice it to say, superservers suit customers willing to pay a premium for ultrahigh reliability and availability.

The movement of mainframe features into servers entails boosting the performance and reliability of basic subsystems (i.e., CPU, memory, and storage), designing for greater capacity and expandability, and adding built-in system management. These changes basically define what separates servers from desktop systems.

More Robust PCs

The first major area of improvement is in processing horsepower. In sheer processing terms, today's servers are every bit the equal of earlier-generation minicomputers and mainframes. A Pentium chip offers 100 MIPS or more of performance. The next-generation Intel P6 is expected to provide 250 to 300 MIPS, putting it squarely in the range of conventional mainframes. PC servers from numerous players are starting to support SMP (symmetric multiprocessing) configurations with two, four, or more CPUs, which can offer near-linear performance boosts if the OS and applications are multithreaded.

The availability and acceptance of SMP will surge in the next few years because Intel has helped legitimize it through MPS (Multiprocessing Specification), which first appeared in 1994 in shared-cache dual-processor Pentium systems (known by the code names P54C/CM). MPS is implemented in Intel chip sets and extends to dedicated-cache, shared-memory configurations of Pentium (and eventually P6) systems. By establishing a baseline standard, Intel has helped make SMP a commodity; server makers will thus have to resort to more specialized features to stand out from the pack. IBM, for one, has aimed high by licensing the 400-MBps C-bus II technology from Corollary (Irvine, CA) for its PC Server 720, a 100-MHz Pentium-based, four-way SMP machine.

Very fast processors rely on caches to bridge the gap between CPU and memory performance. Most Pentium desktop systems provide 128 to 256 KB of external (level 2) cache memory, in addition to the 16 KB inside the chip. Many servers (e.g., the Compaq ProLiant 4000, certain Tricord models, and the IBM PC Server 720) use 512 KB of cache memory. The PC Server 720 also sports a performance-boosting third-level cache, known as a *victim cache*, which buffers memory pages being returned from cache memory to main memory in the event of a cache miss.

Server makers typically implement their own memory-bus designs to boost throughput. Compaq's TriFlex and Tricord's PowerBus, for instance, both run 64 bits wide at 33 MHz, for a peak rate of 267 MBps. Memory configurations are also surging. The ProLiant 4000 server from Compaq accommodates up to 512 MB of ECC (error checking and correcting) RAM and 147 GB of disk storage. The ES5000 superserver from Tricord accepts up to 1 GB of ECC RAM and a walloping 168 SCSI devices—for a theoretical capacity of nearly half a terabyte.

System I/O is improving as a result of the fast PCI (Peripheral Component Interconnect) bus, which operates at speeds of up to 132 MBps (32 bits wide at 33 MHz). Most servers use PCI to connect to storage and the network, and many include EISA or Micro Channel architecture slots for general-purpose add-ins. (Server makers are dumping ISA because it is slow and can't be managed via software.) PCI, EISA, and Micro Channel architectures all permit self-identifying boards and software configuration, but vendors are edging away from EISA because it can't be remotely diagnosed and configured.

PCI suffers from limited support for expansion cards. AST and Digital both plan to bridge PCI buses together as a means of raising capacity (and, incidentally, of filtering bus traffic). However, bus bridging can impose signal latency penalties, notes Larry Shintaku, manager of advanced development for HP's network server division. Another approach, embraced by Apple, is to construct multiple, independently controlled PCI buses, which not only boosts aggregate I/O bandwidth but also affords a measure of redundancy.

Storage performance is raised in servers by using faster drive interfaces, such as enhanced IDE and SCSI (in various configurations, up to 20-MBps "fast-wide" SCSI). The next wave is Ultra SCSI, which runs up to 40 MBps and could someday climb to 80 MBps. In the Unix world, but coming soon to PCs, are two new serial-interface standards that should further boost drive performance and reliability: IBM's SSA (Serial Storage Architecture) and FC-AL (Fibre Channel–Arbitrated Loop). (See the text box "Faster Storage Is Key" on page 52.)

continued

PCs Acquire Mainframe Features

Today's PC servers have every bit the processing power of earlier-generation mainframes.

- 250+-MIPS CPUs
- SMP
- bigger caches, more memory and storage
- faster disk interfaces
- hot swapping, mirroring, RAID
- redundancy of key subsystems
- hardware diagnostics
- 32-bit OSes
- preemptive multitasking
- system management
- remote diagnostics

Faster Storage Is Key

Storage speed is the most important performance factor in servers. After a period of relative stasis in storage interfaces, three technologies are emerging:

Ultra SCSI

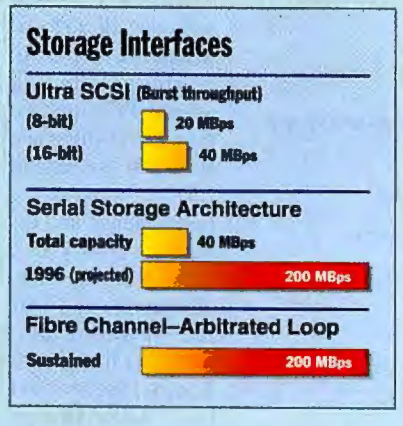
Considered by some an interim step toward serial interfaces, Ultra SCSI represents the latest improvement to the decade-old technology. Ultra SCSI uses the same command set as its predecessors (i.e., SCSI-2 in various configurations) and the same parallel ribbon cable. But by doubling the clock rate of the bus, Ultra SCSI offers burst throughput of up to 20 MBps for 8-bit connections and 40 MBps for 16-bit connections. SCSI champions suggest that one final ratcheting of parallel SCSI technology might someday yield an 80-MBps rating.

Serial Storage Architecture

IBM's SSA is a serial implementation of the SCSI-2 command set, offering 20 MBps of bidirectional throughout, for a total capacity of 40 MBps. (Plans call for capacity to rise to 200 MBps in 1996.) SSA is implemented not as a bus but rather as a series of independent hops among up to 126 hot-pluggable, self-configuring devices. IBM intends it as a low-cost universal solution for local storage. Early supporters include Adaptec, Conner, Future Domain, Micropolis, NCR, and Western Digital.

Fibre Channel–Arbitrated Loop

Based on work done by the IEEE's Fibre Channel committee, FC-AL is another serial interface that does not, despite its name, require a fiber connection. Based on SCSI-3 commands, it offers data transfer rates of up to 200 MBps and supports 126 hot-pluggable, self-configuring devices on a loop. Promoters argue that FC-AL tolerates drive failures better and, because of its close ties to Fibre Channel, could be used as a universal interconnect for both systems and storage. Supporters include Adaptec, BusLogic, Hewlett-Packard, Q-Logic, Quantum, NCR, and Seagate. SSA partisans fault FC-AL for being more expensive and consuming more power. IBM supports both interfaces: SSA for storage and Fiber Channel for system interconnect.



Improved Reliability

Aside from performance and capacity, the features that are most driving PCs to be like mainframes are improved reliability, diagnostics, and system management. Adoption of ECC memory, for instance, has exploded in the last few years. (The memory chips are the same as normal; what's different is that 10 or more bits are used to store each byte so that incorrect values can be algorithmically detected and corrected.) PCs have long used the more prosaic parity checking for memory chips, but not across buses. Almost all servers parity-check all buses, and high-end systems use ECC across bus and cache lines. AST has gone even further in its Manhattan servers, using ECC in the SCSI subsystem and disk controllers, says product marketing manager Chris Norman.

For fail-safe operation, some servers offer redundant power supplies and fans. Others, such as IBM's machines, provide hooks into external UPSes (uninterruptible power supplies). Today, only very high-end superservers today offer redundancy in the form of duplicate processor boards, system or I/O buses, and I/O controllers.

Because a disk is the component most likely to fail, server vendors have given particular attention to storage reliability. This takes the form of both hardware and software capabilities, for example, RAID with sophisticated controllers and software to manage hot swapping, disk mirroring, backup, HSM, and preventive diagnostics.

Management Issues

"The main characteristic of mainframes was their system management structure," says Michael Coleman, general manager for PC Servers at IBM. "They could run themselves." While Coleman acknowledges that "we don't have that kind of maturity yet in the PC space," he and many others argue that the situation is getting dramatically better.



Built-in hardware diagnostics make it possible for software tools to monitor and report on system status, fix problems on-line, and even take preventive action against system failures. The Pentium, P6, and PowerPC chips are able to report significant amounts of information about their status. Instrumented subsystems—including memory, drive controllers, and buses—provide real-time status information. And OSes are shipping with better analysis tools, such as the Performance Monitor supplied with Windows NT. "From an instrumentation perspective, Performance Monitor has many more objects than most mainframes ever had," says Mike Nash, the Windows NT Server group product manager.

New PC-based system management platforms (e.g., IBM's NetFinity, Compaq's Insight Manager, AST's Percepta, HP's NetServer Assistant, ALR's NetTune, and Intel's LANDesk) offer the best of mainframe utilities with the added benefits of a GUI and desktop integration. These system tools typically address several key areas: inventory/asset management, storage management and backup, remote control, security, error logging, diagnostics, performance monitoring, and capacity utilization. Some incorporate predictive failure analysis, capacity planning, and software distribution or metering.

Superservers do quite well with systems management, since this is largely how they justify their higher prices. For instance, the Tricord Intelligent Management System combines software, a dedicated 386

What PCs have that mainframes don't	Where mainframes still excel
• GUIs	• Multiuser OSes
• User preferences, user programming	• I/O architecture optimized for many users
• Distribution of processing among front and back ends	• Enterprise-wide system management tools
• Dynamic resource binding, loadable software modules	• Enterprise applications
• Inexpensive components allow for customization	• Scalability
• Easier-to-use system management tools	• Reliability and availability
	• Security

Most of today's client/server development tools force your applications to be driven by the outward appearance of things.

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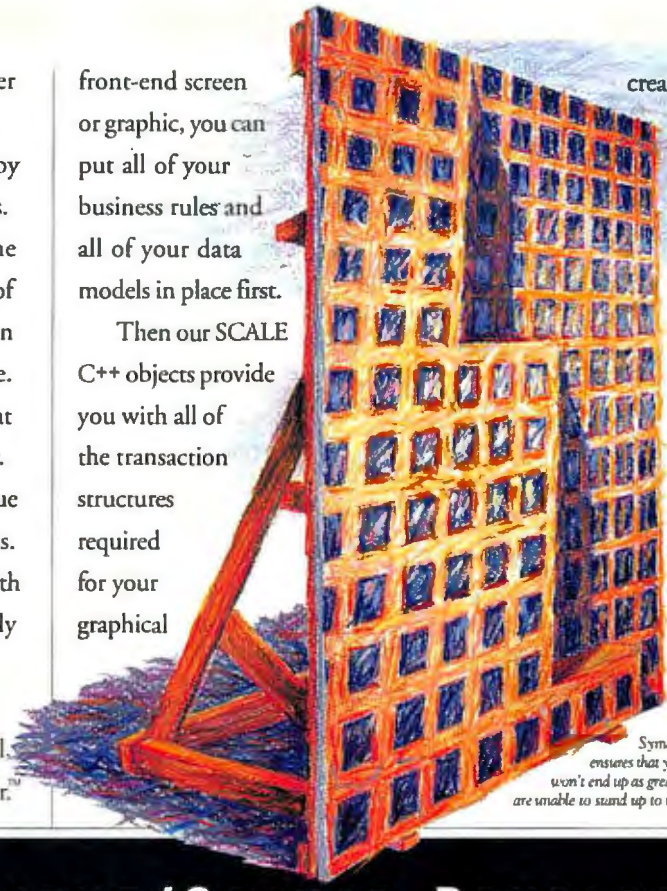
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MANAGING THE ENTERPRISE.

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processor, nonvolatile memory, a modem, and interfaces to the server's bus and power system in a package that can track server status and even call out to a pager for help. Battery backup keeps Tricord's system running three days in the event of server failure.

IBM's PC Server 720 goes even further, by incorporating a separate management bus called the I²C. (It has to be separate, IBM says, because it can't rely on the same components it's monitoring.) The 720 also includes a service processor, a feature that's lifted right out of mainframes, which tracks system status (i.e., temperature, capacity utilization, and memory errors) and controls the power supply, variable-speed fans, hard drive hot-plug system, and a front-panel LED for displaying diagnostic messages.

Your Next Mainframe?
PowerEdge SP 590-2
Dell Computer Corp.



Dell's PowerEdge SP 590-2 is built around a pair of 90-MHz Pentium processors supported by up to 512 MB of main memory and 2 GB of disk storage.

Many server makers have started supporting SNMP agents because SNMP is the de facto standard in network management. But to address system issues in a more standardized way, HP, IBM, Intel, Microsoft, and dozens of other vendors have created the DMTF (Desktop Management Task Force) and defined DMI, a cross-platform standard for characterizing system attributes. In combination with the Microsoft- and Intel-led Plug and Play initiative, DMI should go far toward solving a major problem in distributed PC LAN systems—the inability to manage down to the level of the desktop.

At higher levels in the management hierarchy, the tools are quite sophisticated. Programs such as NetFinity are being upgraded to talk to such frameworks as IBM's NetView and HP's OpenView. Even Novell's NetWare Management System (now a part of ManageWise), which used proprietary agents in its early releases, is opening up to SNMP agents and being upgraded to fit into enterprise management environments.

Microsoft's NT System Management Server manages server applications and Windows-based desktop systems, but some fault it for being too Windows-centered. "SMS is a good solution for homogeneous workgroups where you have Windows desktops and NT servers," says Eric Schmidt, chief technology officer for Sun Microsystems (Mountain View, CA). "But frankly, it's a joke with respect to the enterprise."

Future Tension

Given how PCs are getting to be more like mainframes, what does the future hold? Will centralized or distributed systems prevail? Will computers become more specialized and differentiated, or more commoditized and software-defined?

One direction seems inevitable: Computing is evolving into more of a *service*, or information utility, in which the user neither knows nor cares what hardware or software is running at the back end. "What I wish for is a plug in the wall," says Jeri Edwards, director of transaction services at Tandem Computers.

In this scenario, the user interface hides the complexity of the network, and the network exposes an endless wealth of resources. Bill Gates has abbreviated this notion in his oft-repeated phrase, "information at your fingertips."

Implicit in this vision is the concept of a single system image. This was relatively easy to provide if you were running on a centralized system or cluster, but it's much harder to create and maintain in a distributed environment (especially if resources are free to join and leave the network dynamically). Networking companies are paying attention to this problem, because

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❶ The CPU, a vacuum-tube arithmetic and logical unit, had a built-in 20,000-character ferrite-core memory that featured a 17-microsecond character cycle during processing.

❷ Tape units fed data at a rate of 15,000 characters per second. A reel of tape held 5 million characters at a density of 200 characters per inch.



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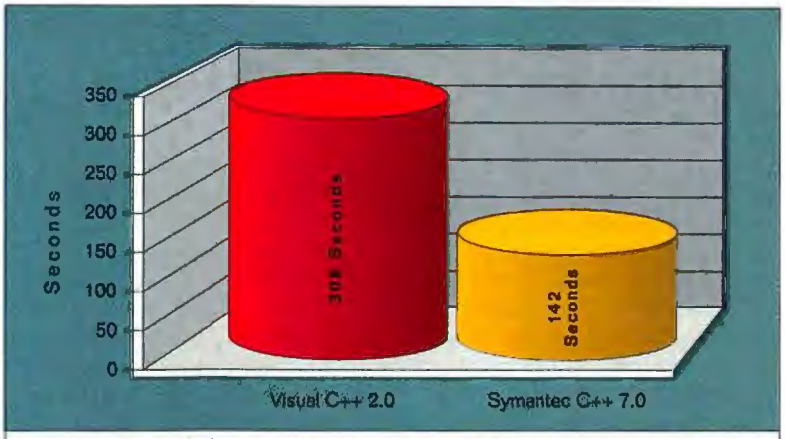
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Circle 126 on Inquiry Card.

PC Software Gets More Potent

PC OSes are growing up. OS/2 and Windows NT are 32-bit flat-memory systems that run in protected mode, multitask preemptively, and support virtual memory—all classic mainframe features.

"A protected-mode OS is the key to robustness in PCs," says Roger Alford, president of Programmable Designs (Ann Arbor, MI). Carl Amdahl of NetFrame Systems (Milpitas, CA) concurs: "You have to be able to kill an application and have the OS stay alive and well."

Windows NT could have a very bright future as a general-purpose server OS because of several crucial architectural features. It was designed to be both a client and a server—in peer and client/server networking schemata—and is both a NOS (network operating system) and an applications platform. It was also written to ride on a HAL (hardware abstraction layer), which hides the specifics of the machine behind a generalized interface. Because of HAL, NT has been successfully ported to a variety of systems built on x86, Alpha, PowerPC, and Mips processors. NT also supports SMP (symmetric multiprocessing), software- and hardware-implemented RAID, and performance monitoring.

OS/2 is available with support for SMP and will soon run on the PowerPC. NetWare support for SMP is expected to ship this summer. And the full gamut of high-end OS features—including 32-bitness, multitasking, SMP support, and management tools—has been available for years in SCO Unix, Novell's UnixWare, and Solaris for x86 and Interactive Unix from SunSoft.

Though NetWare's performance benefits from kernel-mode operation, its reliability suffers: The NOS is subject to crashing from conflicting NLMs (NetWare loadable modules). Fortunately, this isn't the problem it would be in a general-purpose OS, because end users typically don't load software onto servers. But NetWare must evolve task isolation and preemptive multitasking to become a credible application server, which is precisely what Novell plans to do in SuperNOS, a next-generation OS combining NetWare and UnixWare.

if it is effectively solved, it won't matter to users whether they are attached to a host, a server, or a network of PCs.

"What you want is to be able to plug into a single wire and see a consistent set of services," says Firmage. "NDS [the NetWare Directory Service in release 4.x, which provides for a single network log-in] was a first step; next we want to provide a single image of the network file system." Volumes would thus be completely logical and locationless, so you could map to any resource on the network.

Of course, a single system image does not imply that all or even any of the programs you use are executing on a central server using the shared-logic model of mainframes and minicomputers. But significant parts of a distributed application could be executing on a central system, depending on such factors as the location of the target data, network load balancing, or the capabilities of the central machine (i.e., if it is optimized for ad hoc queries, floating-point calculations, or rendering).

The Cost of Data

One of the main factors encouraging distributed computing is the cost of data communications, in terms of both performance and money. Pushing data out to the field, closer to the people using it (i.e., putting data onto LAN servers instead of requiring users always to fetch it from a central computer), can improve access speed and reduce communications costs. It also creates an enterprise-wide parallelism, because users at multiple sites can deploy processing resources simultaneously against local copies of a shared database.

But this begs a vital question: If communications were to approach limitless bandwidth and zero cost, would system managers choose a centralized model because of its inherent advantages in security and data management? Or do other factors, such as hardware cost and scalability, make distribution more desirable?

IBM's Baum asserts that high-bandwidth communications can promote either centralization or decentralization. (The former, because it reduces the penalty of accessing shared data; the latter, because it makes distributing data faster and less expensive.) But bandwidth isn't the only factor. Latency is also a key performance issue. "The speed of access to disks is much better—on the order of milliseconds—if you're closer, compared to hundreds of milliseconds or more if you go out across the network," he says. Certain classes of problems have an "affinity" for data and are thus better addressed on a central computer.

Centralization doesn't imply using traditional mainframes; you can build networks around fault-tolerant Unix machines or NetFrame superservers. Vendors of such mainframe-replacement systems normally sing the praises of centralization. "Tandem has been able to do distributed processing forever, with a single system image across hundreds of processors," says Edwards. "But people still choose to centralize because of security and easier system management." And, she adds, centralized systems reduce MIS staffing needs compared to setups that require a system administrator in every office.

"It's easier to distribute applications rather than data," Amdahl says. He adds that distributed data is harder to control, and you have to administer tricky database tasks, such as replication and versioning. "The last thing IS people want to do," Amdahl says, "is to partition data across more than one machine." What happens if the network breaks and parts of the database become inaccessible?



One application where centralization isn't questioned is video-on-demand, which explains why makers of both mainframes and massively parallel supercomputers are pursuing video serving with such interest. In video-on-demand, one copy of the video file is maintained at a central location, and it's streamed out to users over a switched network, not copied to their local devices. (This model would hold true for any application involving a static data source accessed by millions of users.)

continued

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"Creative Labs just keeps on improving on the design that made it famous. This latest revision of the Sound Blaster features a host of innovations. For example, it has both a 20-voice FM synthesizer and a 32-voice digital sample playback synthesizer for more realistic MIDI sounds. The QSound feature delivers surround-sound effects to your WAV files or you can choose to enhance them with such effects as stuttering and echo. Lots of useful applications come in the box, too, including the easy-to-use VoiceAssist speech-recognition software and well-rounded TextAssist for text-to-speech tasks."

Home Office Computing / January 1996

PCComputing MVP Winner

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"The Sound Blaster AWE32 has Creative Labs' suite of sound playback and editing software that does the job with admirable simplicity--and the addition of sequencer Cakewalk Apprentice and the presentation program HSC Interactive SE rounds out the bundle nicely. And of course, the Sound Blaster AWE32 is compatible with software written for older Sound Blasters, so it will work on anything from Windows to Doom."

PC Computing/December '94

"I heartily recommend the Sound Blaster AWE32. The 100% sound-effects compatibility and impressive music capabilities, make AWE32 an excellent all-round performer."

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174 PC WORLD • DECEMBER 1994

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Circle 129 on Inquiry Card.

The Software Mainframe

At the other end of the spectrum are advocates for decentralization, who argue, in effect, that the software is the mainframe. Firmage asserts that attributes such as security, manageability, and even scalability are no longer confined to central systems. "The major disadvantage of centralization is the loss of flexibility," he says. By contrast, with a NOS that virtualizes resources and offers mainframe-class management tools, "all you have to do is plug in commodity servers, and the network software can migrate storage and services among them."

This scenario can also offer improved availability. "You have fault tolerance built in because you have to replicate information around the network from the start," Firmage says. "If you take down a server, or it fails, everything else stays live." Some argue, as well, that distributed systems are more scalable, because you can add new nodes to a network more easily than adding additional power to a central server.

Among the most vocal advocates of distributed systems is Dave Patterson of the computer science division at the University of California, Berkeley. Patterson and his colleagues have developed a distributed version of Unix called GLUnix (an abbreviation for Global Unix) that lets them turn the entire network into a shared pool of processors, memory, and disks. "Disk, DRAM, and CPU cycles are all valuable," Patterson says.

Studies show that on average more than 60 percent of the CPU capacity of a network is idle. If you need to run a large batch job, why not have the network farm it out to the unused PC of a colleague who's out of town? "If you have a big program and it doesn't fit on your desk, GLUnix can harvest the DRAM elsewhere by memory paging over the network," Patterson says. Similarly, it can "steal" cycles from remote CPUs or "borrow" disk space from remote disks. "This opens up new approaches to traditional system services—virtual memory, file caching, disk striping—as well as opportunities for large-scale parallel processing within an everyday computing infrastructure," he says.

Taking a cue from RAID, you might call this concept RAIS, for redundant arrays of inexpensive systems, because it's founded on the precept that high-volume commodity PCs are the cheapest form of CPU power. Patterson asserts this point vehemently. "You can buy a whole PC for less than the cost of a processor module designed for a small-volume, specialized backplane," he says. "The problem with servers is that their backplane doesn't get better as you own it. You pay a real premium to buy SMPs and servers."



As appealing as RAIS may be, however, many people doubt it will ever be practical. "Not all problems are amenable to being distributed across a large number of smaller machines," says Amdahl. The problem with cycle stealing, he and others contend, is that CPU power is less expensive than network bandwidth. The logistics and overhead of software coordination could outweigh the benefit of stealing cycles, and managing a distributed network could cost more than the savings in hardware expenditures.

Furthermore, argues Mike Perez, vice president of engineering for Compaq's systems division in Houston, Texas, combined commodity boxes don't necessarily equal the capability of a robust server. Compaq aims to stay in the mass market and doesn't want to build "washing-machine-type systems," Perez says. "But we still need some amount of fault tolerance and reliability inside our servers." As soon as you differentiate clients from servers, you've moved away from RAIS.



Clustering

The unifying environment that creates a single system image out of a variety of systems is, of course, the network. Even if Patterson's vision of commodity peers doesn't come into widespread use, systems on networks will ultimately have to behave as if they are partners. One promising development along these lines is *clustering*, which is migrating to PC LANs from mainframes and minicomputers. Clustering provides a path to higher performance while maintaining a single system image.

Digital, which has extensive experience with clustering VAXes, has implemented Windows NT–based technology that can span systems built on x86 and Alpha processors. Digital's software lets multiple systems linked across a LAN (no special hardware interconnect is required among the clustered devices) share a single logical address. A benefit is higher availability without the penalty of redundancy. "Mirroring wastes a whole system," says Dave Glasson, Windows NT marketing manager for Digital. "With clustering, you can use both systems on-line, and if one fails, the other takes over."

Glasson says that centralization is attractive because it lets system managers concentrate CPU, disk, and management resources where they will get the biggest bang for the buck. "The question is whether you have to do this with hardware," he asks. His conclusion, which is reminiscent of Patterson's view, is that software is a more cost-effective way to agglomerate. "It's easier to justify buying cheaper devices and turning them over every few years," Glasson says.

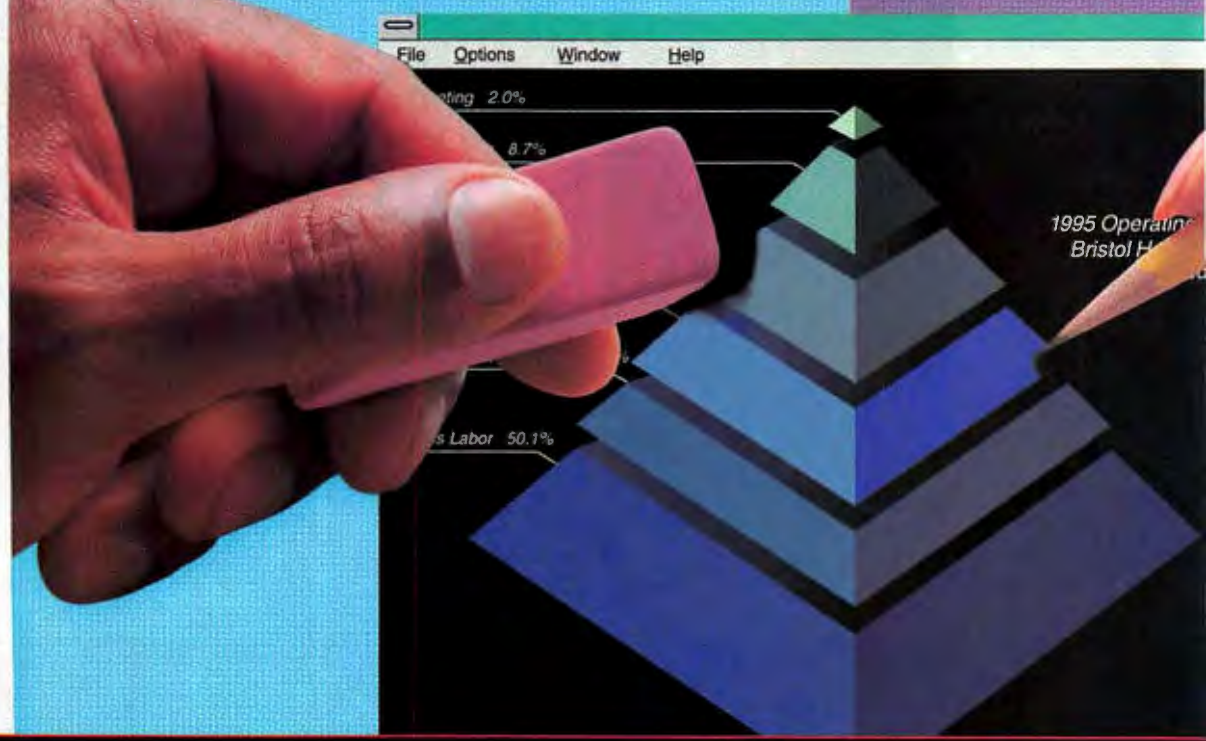
So the mainframe of the future will be made of PCs—more robust than ever but still not the equal of mainframes—in combination with other systems. Both the network and the software will deliver the tools to create a virtual mainframe. And users will appreciate the best of both worlds. "[Our customers] aren't sorry about moving computing power closer to end users—that's the right thing to do," says Pam Casale, director of marketing for enterprise technology at Legent (Herndon, VA). "But they want the efficiency and productivity of remote data with the centralization and control of traditional systems." In other words, they want it all. ■

Andy Reinhardt is BYTE's West Coast bureau chief.


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The British Library's Catalog

DICK POUNTAIN

Two organizations buried in paper, computerization is both a dream and a nightmare. The dream is easily accessible company records that exist as electronic documents. The nightmare? Transforming current and historical paper records into on-line documents can be excruciating, due to the sheer volume of paper and the variety of formats.

The British Library has successfully faced this challenge, converting its massive and unwieldy paper catalogs into an on-line, easily searchable resource. Just one of the BL's catalogs fills 366 volumes of 500 pages each. The catalogs describe a collection of some 18 million books (which grows by 1000 books a week). The new OPAC (On-line Public Access Catalog) system lets researchers perform detailed catalog searches rapidly in a multitude of languages.

The BL's solution uses personal computer clients running Windows (for multiple font handling). A two-tier client/server structure fields queries from the clients and accesses the full-text retrieval system. While the fully inverted file index is large (about 5 GB), it is fast and contains every word in the catalogs. The fact that OPAC was delivered on time and does its job effectively offers lessons for companies making the transition from paper-based records to electronic documents, especially where multiple languages and search capabilities are important.



Anthony Brickell of the British Library

STEPHEN DODD/LIAISON INTERNATIONAL © 1995

Problems with bales of paper documents? The British Library's catalog of millions of items goes on-line.

A Bibliophile's Heaven

The government-funded BL is one of the world's oldest and most important libraries, exceeded in size only by the U.S. Library of Congress, which contains 27 million books, and the Russian state library. Of the BL's 18 million books, about 30,000 are on open public access in the famous neoclassic Round Reading Room, where Edward Gibbon wrote *The History of the Decline and Fall of the Roman Empire* and Karl Marx wrote *Das Kapital*.

There are now several more reading rooms, because the BL has taken on the responsibility for housing the nation's patents, newspapers, periodicals, science reference and map libraries, and official government publications. There are also special collections, such as the India Office Records, sound archives, and the Oriental Collection. The total number of items the BL has charge of is a staggering 150 million.

Every U.K. publisher must, under law, lodge copies of new books, magazines, and newspapers with the BL, so the vast collection is growing. During 1994 alone, 68,000 books and 180,000 issues of newspapers were added.

In the dream world of boosters of the information superhighway, all this material would already be digitized and available on-line. A glance at those numbers, however, suggests that this will take years, or even decades, to achieve. Also, the collection contains documents in several hundred languages, living and dead, many in ancient scripts for which OCR scanning is still a distant prospect.

Cataloging such a collection is an enormous task, and it's here that the BL has successfully applied computer technology. The BL's major printed catalog was published in 1971 as the "General Retrospective Catalog of Printed Books" in 366 volumes. It and other catalogs are now available electronically as the OPAC system. Users of the reading rooms can browse OPAC via personal computers, some fitted with touchscreens, running Windows-based software.

OPAC has been installed in the Round Reading Room and several others. It's amusing to speculate how famous users of the room's past, say, George Bernard Shaw or William Butler Yeats, would have reacted to the glowing monitors.

Learning the Lessons

Why did the BL want to computerize? OPAC system manager Richard Carpenter says, "We wanted to provide an automated

Is On-Line

book-request system to improve the efficiency with which we deliver books to our readers, and that more or less dictated that we automate the catalog, too." This long-term goal of fully automated book delivery was broken down into three subsystems: OPAC, RAS (Reader Admission System), and ABRS (Automated Book Request System).

OPAC was built first. Before going ahead with full development, the BL built a small prototype system based on the BL's old IBM mainframe database and Acorn Archimedes personal computers as terminals. The prototype system let the development team play with some user-interface ideas that found their way into the final product, but otherwise the prototype was completely scrapped in favor of a clean start.

The U.K. consultancy firm Hoskyns, working with the BL's own computer staff, carried out the design-and-analysis phase for the full OPAC system. In-house staff performed the build-and-integration phase, assisted by freelance programmers and project management advisers from Hoskyns. OPAC employed between eight and 10 programmers for over three years (four were full-time BL employees; the rest were freelance), spending around 26 worker-years in all. The project's cost approached £1.8 million (US$2.7 million).

The most obvious lesson learned from implementing OPAC is that modularity is the key to managing system complexity. Modularity pays off all along the route, from coding through maintenance to future upgrading. Both hardware and software in the OPAC system are modular.

OPAC employs a split-level client/server architecture that has proved effective in balancing out communications loads even when using lines of relatively modest bandwidth into the data server. Using RPCs (remote procedure calls) turned out to be a viable way to do networked queries because it simplified the writing of the search software and helped isolate the software/hardware dependencies, allowing for easier upgrades.

The choice of a full-text retrieval system rather than a more conventional RDBMS (relational database management system) proved invaluable in accommodating a mass of legacy texts in variable formats without losing the power to search them at will. Full-text retrieval also removed the need to second-guess what terms might need to be indexed in new texts, which in the case of a library as diverse as the BL would be almost impossible. Many businesses could benefit from taking a similar approach. This would enable users to retrieve documents using criteria that were not thought of when the business first filed them and to answer previously unexpected questions.

During the development of the software, things did not always run smoothly. Some of the modules slipped behind schedule, but OPAC's modularity helped absorb such delays. For example, the data-server back end was running earlier than expected, so the team began loading catalog data before some of the software modules were finished. This saved time that was allocated

COMPUTERIZING A LARGE MULTILINGUAL CATALOG



The Problems

- A paper-based catalog of 18 million volumes and a growing collection of documents.
- Catalog entries are in multiple languages and alphabets.
- Require search capabilities on any word in any language.
- Require fast response to searches.
- Users who are not computer-literate.
- Internet access is desired.



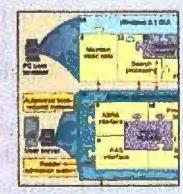
The Solution

- A two-level client/server architecture on Digital minicomputers running Ultrix, using TCP/IP and RPCs as a query language.
- Full-text word search in multiple languages.
- User terminals are midrange PCs with touchscreens.
- Windows TrueType fonts display multiple alphabets.
- The Internet gateway is a Digital minicomputer running Ultrix.



The Benefits

- Simplifies catalog additions and updates.
- Allows rapid searches of a large catalog.
- Searches in multiple languages.
- Enables a follow-on system for book request and retrieval.
- Supports Internet access.



Lessons Learned

- Modular architecture simplifies applications development.
- The two-level client/server architecture handles user interactions and saves the data server for handling queries.
- Using full-text retrieval rather than an RDBMS simplifies the importing of masses of variable-format legacy texts.
- Using a middleware layer can enable Windows clients to work effectively in a TCP/IP networking context.
- Don't wait for vaporware. Unicode would have been useful, but OPAC wouldn't be finished yet if the British Library had waited for it.
- Design with future additions and upgrades in mind.



Circle 168 on Inquiry Card.

Handling Special Character Sets

One big challenge for OPAC (On-line Public Access Catalog) was supporting the numerous ancient scripts that British Library scholars use, including historical variations on Greek and Cyrillic, Egyptian hieroglyphs, and Hebrew and Arabic (which read from right to left). They don't include the thousands of Chinese and Japanese pictographs. The Oriental Collection will be a separate project.

The Windows-based front end made designing the base characters straightforward, using font-building tools like Fontographer from MacroMedia. Much more difficult was handling the large range of diacritical marks these ancient scripts require: It's just not feasible to create a character set containing all the permitted letter-accent combinations. Instead, OPAC displays compound screen characters, with the diacritical marks overprinted at run time. This required custom coding of the display drivers.



OPAC accepts queries written in scripts from previous centuries, such as this Old Slavonic. It can also mix character sets freely on-screen and needs to support a far wider range of diacritical marks than is required for modern languages.

for the end of the project.

The biggest headache proved to be the sloth that the software industry has exhibited toward supporting Unicode, whose ability to handle symbols of the many languages involved could have simplified the creation of OPAC enormously. Nevertheless, the team went ahead rather than wait for Unicode and be late, which may offer a lesson in how to deal with vaporware.

What OPAC Does

The OPAC front end includes a simple user interface driven entirely by pressing function keys or touchscreen buttons. As with the National Gallery project (see "The Fine Art of CD-ROM Publishing," June 1994 BYTE), the BL's development team discovered that the standard Windows look and feel of pull-down menus, scroll bars, and dialog boxes is too busy and complicated for typical library users.

The main attraction of Windows, apart from its low cost and ubiquity, was its TrueType font system for supporting the variety of ancient scripts the library contains (see the text box "Handling Special Character Sets"). Scholars of ancient-language texts must be able to enter queries in the languages and scripts that they are studying. Therefore, OPAC needs to cope with Roman, Hebrew, Arabic, Greek, Cyrillic, and other alphabets on the same screen by user selection.

The user software allows you to frame queries based on title, author, publisher, date, catalog number, or up to five simultaneous keywords or phrases. OPAC also offers proximity searches, thesauri that cope with various spellings, and pivot searches, so-called because they alter the final destination in midsearch by finding more records like the currently selected one.

OPAC forms just part of an integrated book-delivery system the BL intends to deploy in its new library building. The other two components are RAS and ABRS, both of which are under development, and for which OPAC already contains the connecting "hooks." Once this system is fully integrated, you'll sit down at a terminal and pass your reader's card through a slot, allowing RAS to determine what parts of the collection you are authorized to see. When you've found your desired books within OPAC, ABRS will dispatch an electronic order so the books can be delivered to you..

The OPAC Architecture

The raw-material catalogs for OPAC were widely variable in format. Anthony Brickell, who is OPAC's workstation system manager, explains that "the cataloging styles and rules used at different periods by various organizations differed widely, especially in the matter of subject indexing,

Now Everyone Can Have The Superior Monitor.



Photo Credit: Peter John Griffiths/Time-Life Books



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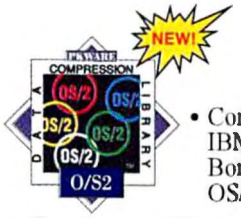
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which varied from none at all to standard systems like Dewey and Precis." This meant that information fields present in post-1971 material are just not present in earlier catalog entries, and different fields are to be found in the specialized subject catalogs.

Merging these catalogs into one would have inevitably meant using only those characteristics shared by all and losing much of the richness that had evolved in the specialized subject catalogs. Thus, the OPAC team decided to retain six catalog databases: the General Retrospective Catalog of Printed Books (everything up to 1971); the General Current Catalog of Books (1971 onward); the retrospective and current Printed Music catalogs; the Science, Technology, and Business current catalog; and a catalog of monographs held at Boston Spa. You can't make direct searches that cross database boundaries. However, you can switch databases and repeat the same search.

The General Retrospective Catalog alone contains 4,361,187 documents and occupies 5.31 GB of disk space. The other five catalogs add up to as much again. (The data server has 41 GB of disk storage, but this will require continual upgrading.) On the other hand, the number of concurrent users is quite modest compared to other distributed computer applications (there are now only 58 user terminals on the OPAC system).

According to Brickell, "We needed to provide fast and powerful searching capabilities, but it was impossible to predict what fields people might want to search on—everything is a possible search index. This pointed us toward using a full-text retrieval system rather than a more conventional RDBMS like Oracle or Ingres."

Accordingly, the BL team built OPAC around a full-text retrieval engine called BRS/Search, which uses a fully inverted file. Inverted file systems (so-called because each word of the original text becomes a pointer back into the text) provide the maximum possible search power because they can locate every single word and are fast. For many applications, inverted file systems may not be appropriate because of the large amount of disk-storage space they consume (see the text box "The BRS Text-Retrieval System" on page 68). However, to achieve the BL's two goals of completeness and speed, sufficient disk space for the search index was a requirement for the system.

According to Brickell, the BL selected BRS/Search primarily for its power. "At the time [1990], there were only two or three products having the sort of power

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that would be needed for our size and complexity of application," he says. "We already had a license from a previous British Library application."

OPAC has a client/server architecture distributed over two separate levels of servers. The user terminals are 486 personal computers (from Dell and Digital Equipment) with 4 MB of memory and 100-MB hard drives. The terminals connect by Ethernet LANs to several user servers, which in turn connect by Ethernet with WAN bridges to a single data server that holds the catalog text and runs the BRS/Search engine.

The user servers are Digital 5000/240 minicomputers that are running both the OPAC search software and an Ingres RDBMS under Ultrix, Digital's brand of Unix. Ingres doesn't hold any catalog text but is a sort of query cache: Catalog searches pass through to the data server, which returns intermediate lists of "hit" terms into Ingres. The user servers also store volatile session-related data, such as users' search histories and usage statistics, and static user-interface data, such as the multilingual help screens and library hours.

The data server is a larger Digital 5900 Ultrix minicomputer, but Brickell says, "We may soon need to move up to one of Digital's Alpha-based machines, and we'd move to an open-systems OSF/1 Unix at the same time." The design of OPAC's software makes such migrations almost painless. A second Digital 5900 (the update server) duplicates the data server. The update server handles adding new catalogs and updating existing ones off-line. This server will eventually also be a backup machine in case the data server goes down.

The user servers are near the terminals they serve (each can support up to 20 terminals): The user server for the Round Reading Room is in the same building. The data server, however, resides in BL's offices in London's Soho district, a mile or so from each reading room. Thus, BL's engineers have implemented a WAN using British Telecom 64-Kbps digital telephone lines, bridged into the various Ethernets. Tony Beaumont, one of BL's telecommunications analysts, has grander plans. "By May, we'll have upgraded OPAC's networks to an Ethernet-over-FDDI [Fiber Distributed Data Interface] fiber-optic backbone, with British Telecom's 10-Mbps LES2 digital lines between the buildings."

The update server is in Boston Spa. For security against theft and hacking, the update data, on DAT (digital audiotape), is transferred via motorcycle couriers between the sites. Once the LES2 lines are in place, it should be possible to switch the update server to "live" on-line operation as a backup system. But the OPAC team is still evaluating how to manage this operation

The two-tier server structure of OPAC provides smooth interactive operation at the user terminals by spreading the communications load in a sensible manner. In the early stages of a search, you are communicating almost solely with the user server, and the data server is sending only small amounts of data. It's only when you get close to a final selection that much data is transferred from the data server. I tried the system at a time when the Round Reading Room terminals were 90 percent occupied. As I scrolled through a long list of search hits (9861 texts by Shakespeare), there were slight pauses of about a second as the data server delivered another 20-record chunk.

Available to the public for 12 hours a day on weekdays and 8 hours on Saturday, OPAC has been available for 97 percent of its scheduled time. OPAC's software metric routines can accurately simulate real users. The routines run during the evening and on weekends to simulate greater loads and warn when performance is about to degrade, so faster data servers can be introduced before they're needed.

OPAC Software Development

OPAC's software design is unlike many PC-based client/server solutions, because the problem it solves is different from that faced by a typical PC LAN. OPAC is designed to find needles in haystacks rather than to shift wagonloads of hay.

The first unusual feature is that OPAC employs TCP/IP as its communications protocol, even to its Windows clients. The second is that it does not employ SQL as its query language but rather uses RPCs across both levels of servers. The choice of TCP/IP (rather than NetWare IPX, as used throughout the rest of BL's interoffice LANs) made sense because two of OPAC's three levels are Unix-based and it simplified Internet

THE BRS TEXT-RETRIEVAL SYSTEM

BRS/Search is a full-text retrieval system from Dataware Technologies (Cambridge, MA). It's available for numerous OSes, from Unix, MS-DOS, Windows, and NT, all the way up to Cray YMP supercomputers and IBM mainframes. Under development for 12 years, BRS/Search has 2000 installations worldwide, including large corporations such as Boeing and government institutions such as the U.S. DoD (Department of Defense).

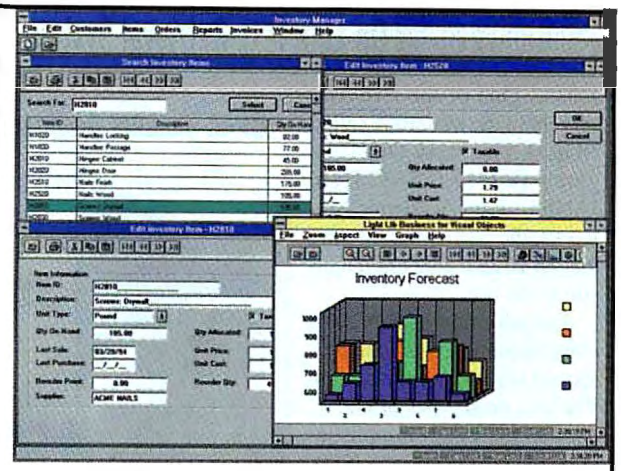
The *full* in full-text retrieval refers to the fact that BRS/Search indexes every significant word of your documents. Thus, the full text is available for you to search on rather than just a few keywords. A user-created list of undesirable common words (e.g., *and*) defines what is considered significant. BRS/Search is also a free-text system in that it does not assume any fixed record structure, though it normally treats documents as being divisible into variable-length paragraphs, sentences, and words (the criteria for recognizing these divisions are also user-definable via a form file).

BRS/Search works by recording the location of every significant word in a document collection. When the British Library loads a batch of catalog entries into the system, BRS/Search creates a sorted dictionary containing every unique word it encounters, and from this it creates an inverted file that consists solely of pointers to the locations of each occurrence of every word in the dictionary. (There is actually a third level of indirection, because the inverted file points to a table of byte offsets of separate documents within a single compressed text file.)

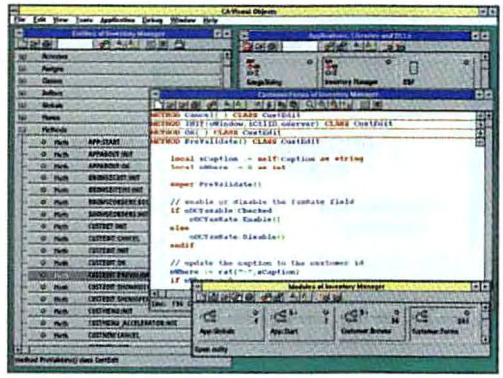
BRS/Search uses proprietary compression techniques to squeeze the inverted file as well as the text itself, so the whole indexed database is often only 20 percent to 50 percent larger than the uncompressed text (many full-text systems more than double the data volume). The use of an inverted file makes retrieval by multiple keywords and proximity searches fast, because the software needs only to compare their occurrence lists in the inverted file without searching the text file at all.

Two features of BRS/Search were important for the OPAC (On-line Public Access Catalog) application. First, it makes all its functionality available to outside software through a procedure-call interface. This fit perfectly with OPAC's RPC-based (remote procedure call) communications method. Second, the software allows databases to reside across multiple disk volumes.

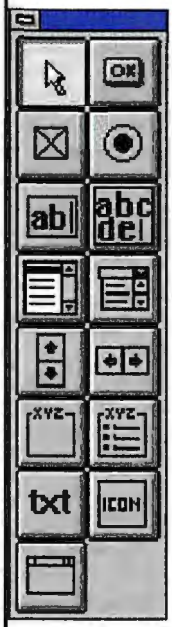
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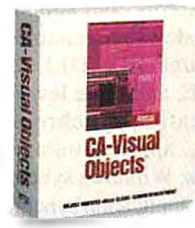
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access. One of the five user servers in the system is called NOPAC (Network OPAC), a gateway into OPAC from JANET (Joint Academic Network), the part of the Internet that all British educational institutions use.

The adoption of RPCs for communication was actually a second iteration of the design. The first prototypes of OPAC used an extremely simple design based on Unix's NFS. BRS/Search would return the results of its searches in a text file, which NFS simply mapped into the client's file space. This NFS scheme workedand required minimal programming effort, but its performance was inadequate. The scheme also posed serious security problems once NOPAC network access arrived, because it allowed remote users to manipulate the server file systems.

So the team replaced the NFS solution with custom software, produced using a middleware product called Netwise TransAccess Application-Integrator from Netwise (Boulder, CO). Hoskyns had employed it on previous projects.

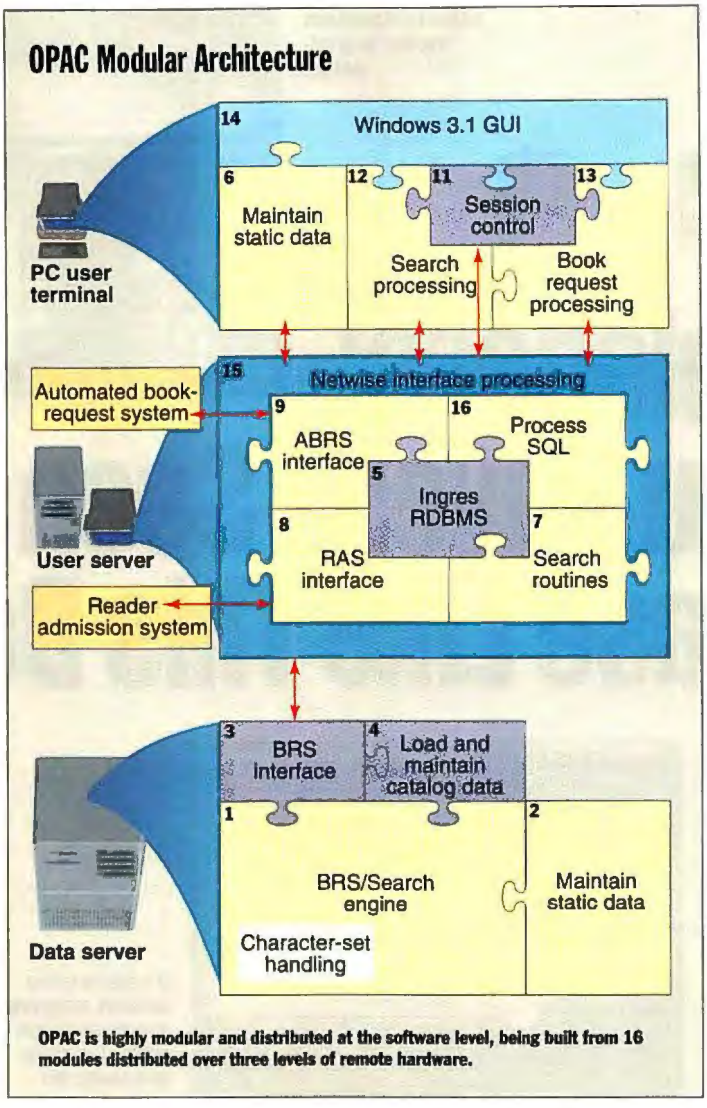
Netwise TransAccess is a C-based development aid that provides low-level communication between different OS environments, hardware platforms, and database formats. One component, Netwise RPC Tool for Windows 3.1, lets Windows programs communicate with servers running in foreign environments via RPCs that Netwise's RPC Poller maps into ordinary Windows messages. Converting low-level network activity into messages enormously simplifies writing Windows client programs. Netwise RPC Tool also enables you to write Windows server programs accessible from remote systems, and supports key Windows programming techniques like DLLs, DDE, OLE, and three levels of application synchronization (i.e., application asynchronous, Windows synchronous, and application synchronous).

To apply the Netwise solution, you write a short network specification file, using a C-like syntax, that describes the physical locations of all the procedures your system employs. Netwise's special compiler turns this file into a linkable module. Once linked, your C code can call functions on remote machines as if they were all part of one program, and the network becomes transparent to your code. Netwise helps isolate the biggest part of OPAC's code from changes of hardware and even OS, which will simplify server upgrades.

The figure on this page depicts the overall software architecture of OPAC, with 16 modules in all. (Note that though this diagram highlights the physical communications links, the linked modules work as if they are talking to a neighbor, thanks to Netwise RPC Tool.)

Module 10, omitted for clarity, consists solely of standard Windows routines used by many other modules. Module 3, the BRS Interface, isolates the BRS/Search-dependent routines from OPAC's own search routines, so that OPAC can easily cope with upgrades to the BRS engine or even a port to another text-retrieval engine should the need arise.

The Windows client software was written in Microsoft C++ using the SDK (Software Development Kit) without any object-oriented features. The interface code between Ingres and BRS/Search is in plain Ultrix C. The interface between Ingres and ABRS (to be added) is in C with embedded SQL, hence the need for module 16.



OPAC is highly modular and distributed at the software level, being built from 16 modules distributed over three levels of remote hardware.

The Ultimate Test

The British Library has surveyed the attitudes of its users since OPAC went online, and the overall impression is favorable. A majority have declared themselves happy with OPAC's searching power, but many have complained of insufficient on-screen guidance and inability to backtrack to previous search levels. Both of these matters will be tackled in the next software revision.

Some 6.5 percent of those sampled do not use OPAC at all, citing a general dislike of computers. But over two-thirds of the users now go to OPAC before the printed catalogs, which is the final test of acceptance. ■

Dick Pountain is a BYTE contributing editor based in London. You can reach him on the Internet or BIX at dickp@bix.com.

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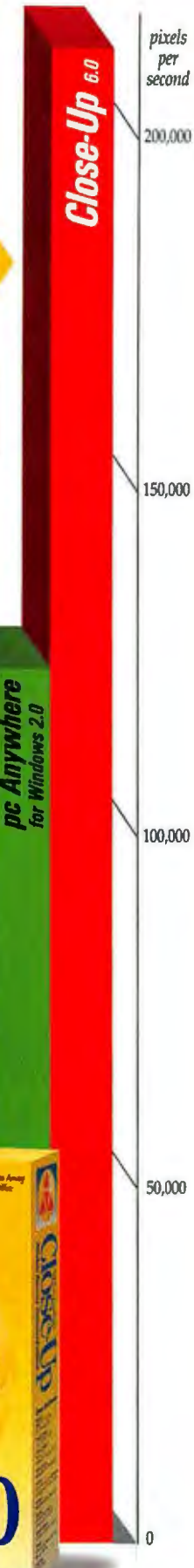
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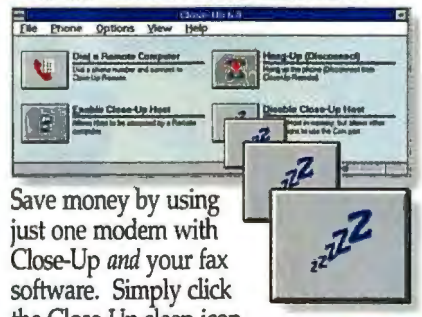
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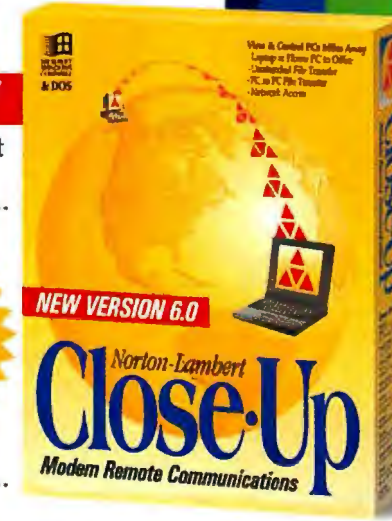
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Windows Sources, February 1995

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1995 Readers' Choice Awards

Apple's PowerPC-based Power Mac systems became widely available in the past year. BYTE readers obviously liked what they saw: The Power Mac family received this year's award for Hardware Product of the Year.

HARDWARE PRODUCT OF THE YEAR

Power Mac series
Apple Computer

Runners-up

LaserJet 4Si, Hewlett-Packard
(tie) Pentium, Intel
ThinkPad series, IBM



This vote of confidence for the RISC-based PowerPC design is significant, given our readership's affection and fascination for innovative technologies. But stay tuned: The race promises to get even hotter in the coming year, as Intel's next-generation P6, along with new processors expected from AMD, Cyrix, and NexGen, vie against the PowerPC to power the advanced servers and desktop systems that BYTE readers demand.

On the software side, readers recognized IBM's OS/2 Warp for its technical merits and named it 1995's Software Product of the Year. But when they cast their votes in the Operating System/Environment category, their choices more closely matched market realities, and Windows won out over Warp. Perhaps more interesting is the product that didn't make the runner-up list in the operating-systems voting. For first time in the history of our reader polls, MS-DOS didn't rank at all; Apple's Mac OS (formerly System 7) usurped MS-DOS's second-runner-up status in last year's poll.

1995 BYTE READERS' CHOICE AWARD

When we polled our readers earlier this year, we asked them to identify the best products in a total of 40 hardware and software categories. We also asked them to tell us what companies provide the best service; for the second year in a row, Gateway 2000 topped the list.

In most categories, the industry leaders either remained on top or jockeyed for position among the winners and runners-up. Nevertheless, there are some notable newcomers. The Mac programmers among our readership bolstered the opinions of BYTE's Mac experts and gave Metrowerks' CodeWarrior the second-highest number of votes in the Mac programming-language category (it captured just a few votes less than Symantec's Think C). Other products new to the rankings this year are Ascend, from Franklin Quest; Designer, from Micrografx; RAM Doubler, from Connectix; and WriteNow, a recent acquisition of Softkey International.

BEST SERVICE (HARDWARE OR SOFTWARE)
Gateway 2000

Runners-up

Hewlett-Packard
Microsoft

This year we added two new categories, for color printers and subnotebooks, to reflect market trends. By contrast, we no longer rank Mac video boards, given the decline of general-purpose cards since Apple began integrating 24-bit color onto Mac motherboards.

Technological advancement continues to define the industry, and few people are better judges of what's significant than BYTE readers. Here, then, are the 50 winners and runners-up that BYTE readers say are offering the best products on the market today.

Desktop Computer
PC

Gateway 4DX2-66
Gateway 2000

Runners-up

Dimension series, Dell Computer
ProLinea series, Compaq Computer

Desktop Computer
Macintosh

Power Mac series
Apple Computer

Runners-up

Quadra series, Mac LC,
Apple Computer

Workstation

HP 9000 series
Hewlett-Packard

Runners-up

RS/6000 series, IBM
SparcStation 10, Sun Microsystems



HP 9000 Model 712/60

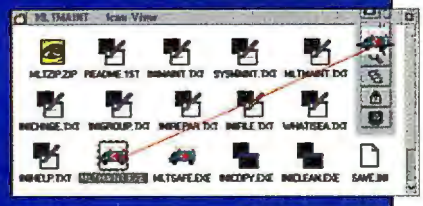


SOFTWARE PRODUCT OF THE YEAR

OS/2 Warp
IBM

Runners-up

Office, Windows NT,
Microsoft



Notebook Computer

ThinkPad 755C
IBM

Runners-up

T4900CT, Toshiba America Information Systems
Mac PowerBook series, Apple Computer

Subnotebook Computer

Contura Aero series
Compaq Computer

Runners-up

Liberty series, Gateway 2000
Portégé series, Toshiba America Information Systems

Hand-Held Computer

MessagePad series
Apple Computer

Runners-up

Sharp Wizard series, Sharp Electronics
HP LX series, Hewlett-Packard

Monitor

MultiSync FG series
NEC Technologies

Runners-up

ViewSonic 17, ViewSonic
FlexScan, Nanao USA

Laser Printer

LaserJet 4Si
Hewlett-Packard

Runners-up

LaserJet 4P, LaserJet 4M
Hewlett-Packard

Color Printer

DeskJet 1200C
Hewlett-Packard

Runners-up

DeskJet 560C, Hewlett-Packard
BJC-600, Canon Computer Systems

Video Board
PC

Diamond Stealth series
Diamond Multimedia Systems

Runners-up

Diamond Viper series, Diamond Multimedia Systems
Graphics Pro Turbo, ATI Technologies

Modem

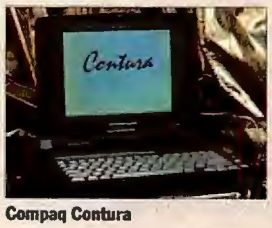
Sportster series
U.S. Robotics

Runners-up

Optima series, Hayes Microcomputer Products
Courier series, U.S. Robotics


Apple MessagePad


NEC MultiSync 6FG



Compaq Contura

Word Processor
PC

Word for Windows
Microsoft

Runners-up

WordPerfect for Windows, WordPerfect/Novell Applications Group
Ami Pro, Lotus Development

Word Processor
Macintosh

Word for Macintosh
Microsoft

Runners-up

WriteNow, Softkey International
MacWrite Pro, Claris

Spreadsheet
PC

Excel
Microsoft

Runners-up

Quattro Pro for Windows, WordPerfect/Novell Applications Group
1-2-3 for Windows, Lotus Development

Spreadsheet
Macintosh

Excel
Microsoft

Runners-up

1-2-3 for Macintosh, Lotus Development
Wingz, Investment Intelligence Systems

Database Manager
PC

Access
Microsoft

Runners-up

Paradox, Borland International
FoxPro, Microsoft

Database Manager
Macintosh

FileMaker Pro
Claris

Runners-up

4th Dimension, ACI US
Omnis, Blyth Software

Database Client/Server
All Platforms

SQL Server
Microsoft

Runners-up

NetWare SQL, Novell
Oracle server, Oracle

Operating System/Environment
All Platforms

Windows 3.1
Microsoft

Runners-up

OS/2 Warp, IBM
Mac OS (System 7), Apple Computer

Network Operating System
PC

NetWare
Novell

Runners-up

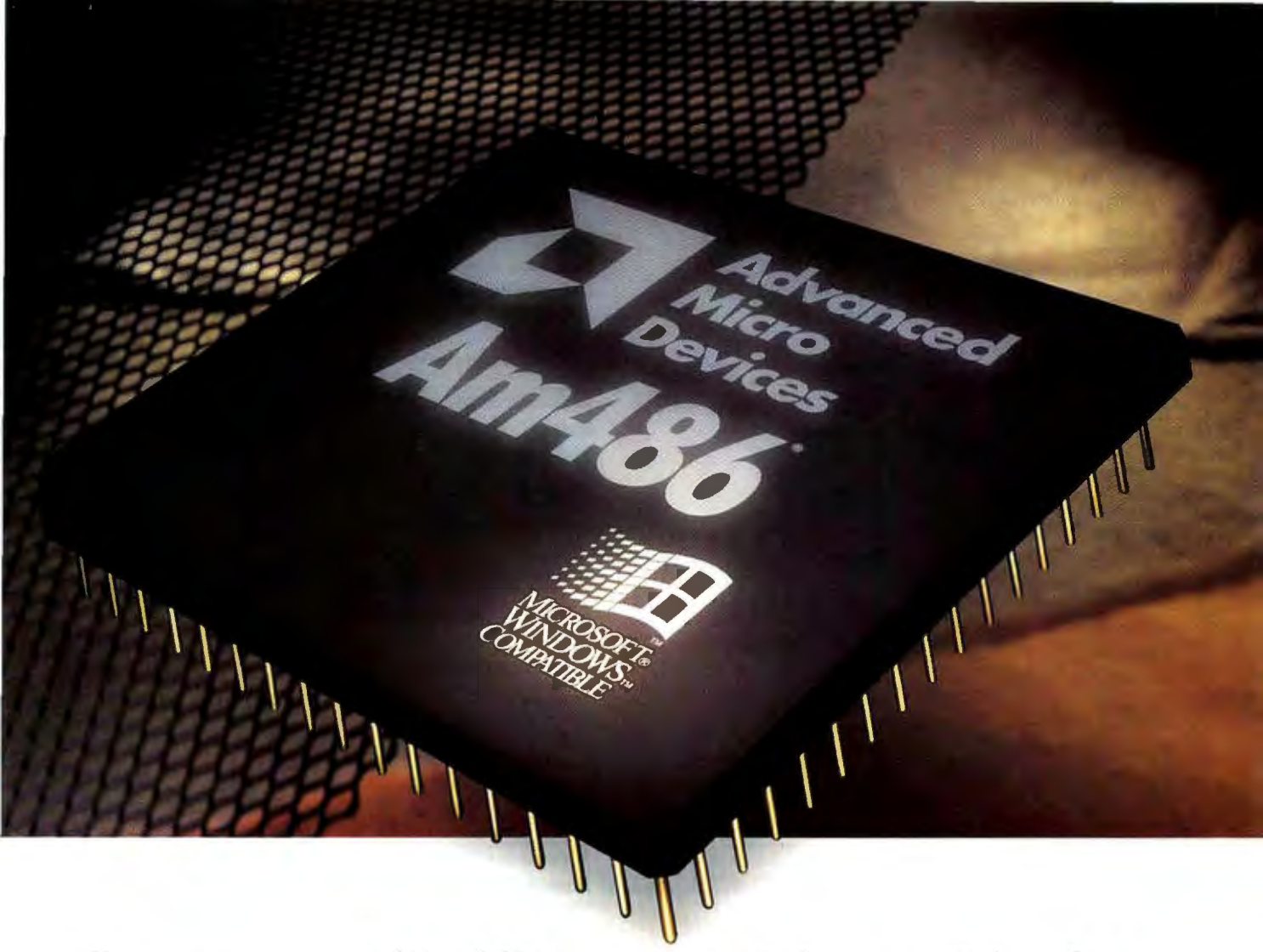
Windows for Workgroups, Microsoft
LANtastic, Artisoft

Network Operating System
Macintosh

NetWare for Macintosh
Novell

Runners-up

AppleShare, Apple Computer
TOPS, SunSoft



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Feature

Programming Language
PC

Borland C++
Borland International

Runners-up

Visual Basic, Microsoft
Visual C++, Microsoft

Programming Language
Macintosh

Think C
Symantec

Runners-up

CodeWarrior, Metrowerks
HyperCard, Apple Computer

Desktop Publishing Program
PC

PageMaker
Adobe Systems

Runners-up

Ventura Publisher, Corel
Publisher, Microsoft

Desktop Publishing Program
Macintosh

PageMaker
Adobe Systems

Runners-up

QuarkXPress, Quark
Ventura Publisher, Corel

Desktop Publishing Program
Unix

FrameMaker
Frame Technology

Runners-up

Interleaf, Interleaf
Island Write/Paint/Draw,
Island Software

CAD Program
PC

AutoCAD
Autodesk

Runners-up

Generic CADD, Autodesk
Microstation, Intergraph

CAD Program
Macintosh

DesignCAD Macintosh
American Small Business Computers

Runners-up

Claris CAD, Claris
Vellum, Ashlar

Graphics Program
PC

CorelDraw
Corel

Runners-up

Illustrator, Adobe Systems
Designer, Micrografx

Graphics Program
Macintosh

Illustrator
Adobe Systems

Runners-up

FreeHand, Macromedia
MacDraw Pro, Claris

Presentation Graphics Program
PC

PowerPoint
Microsoft

Runners-up

Freelance Graphics,
Lotus Development
Persuasion, Adobe Systems

Presentation Graphics Program
Macintosh

PowerPoint
Microsoft

Runners-up

Persuasion, Adobe Systems
CA-Cricket Presents,
Computer Associates International

E-Mail/Workgroup Software
PC

Mail
Microsoft

Runners-up

cc:Mail, Notes, Lotus Development

E-Mail/Workgroup Software
Macintosh

cc:Mail
Lotus Development

Runners-up

Mail, Microsoft
QuickMail, CE Software

Project Management
All Platforms

Project for Windows
Microsoft

Runners-up

CA-SuperProject,
Computer Associates International
Harvard Project Manager,
Software Publishing

Contact Manager/PIM
All Platforms

Organizer
Lotus Development

Runners-up

Act, Symantec
Ascend for Windows and Macintosh,
Franklin Quest

Utility Package
PC

Norton Utilities
Symantec

Runners-up

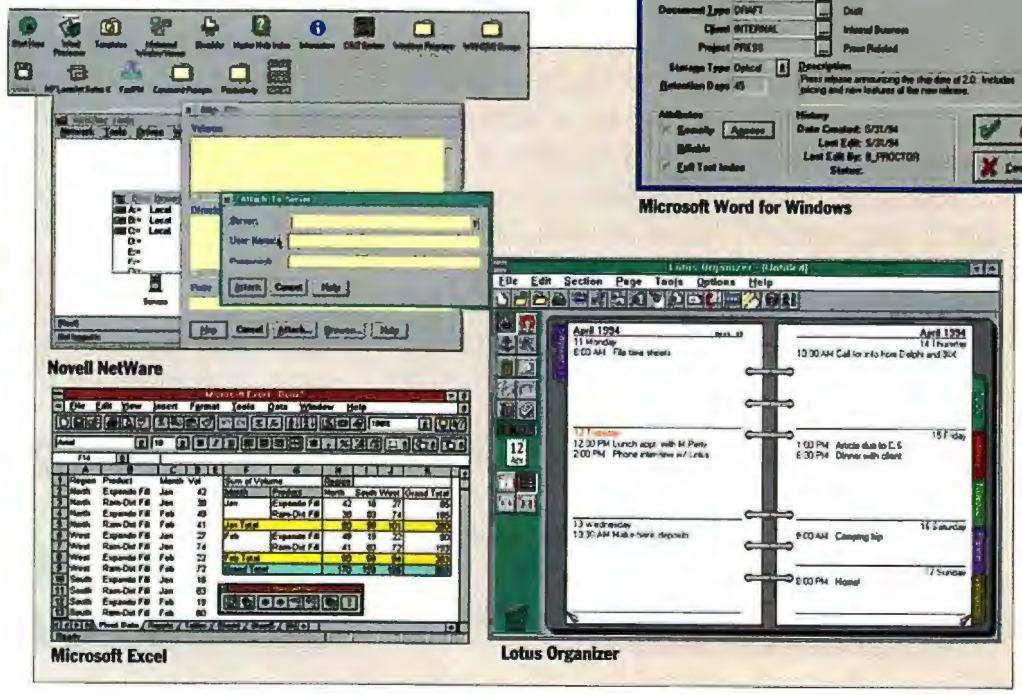
PC Tools, Symantec
Norton Desktop for Windows,
Symantec

Utility Package
Macintosh

Norton Utilities Mac
Symantec

Runners-up

MacTools, Symantec
RAM Doubler, Connectix



Microsoft Word for Windows

Novell NetWare

Microsoft Excel

Lotus Organizer



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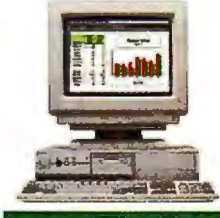
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See You Around

TOM R. HALFHILL



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Panoramic video, using Apple's QuickTime VR and Microsoft's Surround Video, enables photo-quality virtual reality on your computer screen

Panoramic video technology—perhaps the first new form of photography to be invented in this century—puts you in the middle of a wraparound, photo-quality, virtual-reality world with no need for helmets, goggles, or gloves. Apple's QuickTime VR, unveiled in June 1994, gained national attention when NBC News adapted it to create panoramas of crime scenes during the murder trial of O. J. Simpson. Simon & Schuster's CD-ROM, titled Star Trek: The Next Generation Interactive Technical Manual, was the first retail product to use QuickTime VR. Released in November, the Star Trek CD-ROM (see "Books and CD-ROMs: Star Trek Meets QuickTime VR," March BYTE) quickly sold more than 200,000 copies.

Developers of game and educational software love this technology because it enables them to photograph scenes that aren't practical to render artificially. WNET, a PBS station in New York, is using QuickTime VR to create a panoramic tour of the Serengeti Plain in Africa. Sumeria, a multimedia developer in San Francisco, is working on QuickTime VR tours of Mayan ruins in Central America.

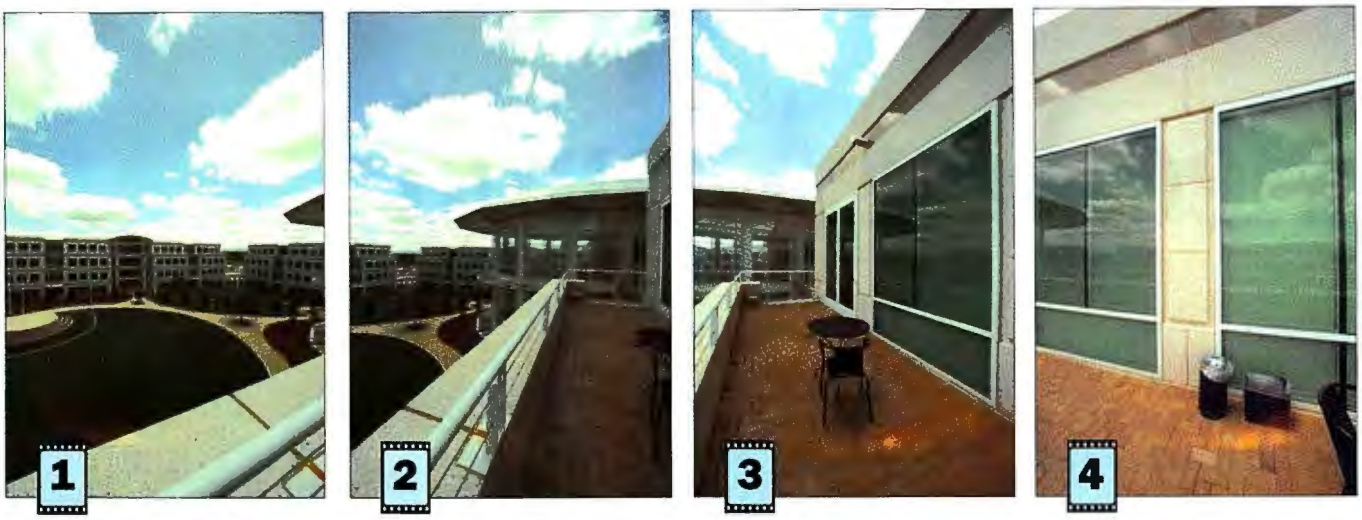
Businesses can use panoramic videos to familiarize employees with the layouts of mazelike factories or offices. Law-enforcement agencies can use panoramas to train SWAT teams. And ultimately, it's possible that panoramas photographed with tiny fiber-optic lenses could open interior spaces, such as the human body, to interactive exploration.

Although QuickTime VR panoramas can be displayed on Windows PCs as well as on Macintoshes (the Star Trek CD-ROM is available for both platforms), the special authoring tools run only on a Mac. That limitation prompted Microsoft to embark on a crash program last October to make its own version of QuickTime VR. The result, Surround Video, is scheduled for release as an SDK (Software Development Kit) this spring.

In some respects, Surround Video is not as advanced as QuickTime VR (see the table "QuickTime VR vs. Surround Video" on page 89). To users, however, it appears very similar to QuickTime VR on the screen, and it will almost certainly attract developers.

Four characteristics, listed below, set panoramic video apart from previous technologies.

- Unlike other forms of virtual reality, these panoramas are not limited to computer-generated images. QuickTime VR and Surround Video use digitized photos of real-world scenes (although they can also use rendered images or combine elements of both).
- Despite their misleading names, QuickTime VR and Surround Video do not require motion-video footage. (But conventional



video and animation can be used as layers on the backgrounds.) Since the panoramas are derived from still photos, they don't restrict you to viewing a scene in any predetermined linear sequence. Navigation is completely interactive.

• Panoramic video is the only way to map 360-degree panoramas onto a flat surface (in this case, a video screen) without distortion. Photographers have been shooting panoramas since the nineteenth century, but true 360-degree photos suffer from optical distortion unless you bend them into a cylinder and view the panorama from inside. QuickTime VR and Surround Video automatically correct that distortion through software.

• Panoramic videos are interactive in ways that are impossible without a computer. For instance, developers can link panoramas together so users can change viewpoints by clicking on predefined hot spots. Also, QuickTime VR lets you zoom a panorama to higher magnifications and view objects from any angle. (Early versions of Surround Video lack these capabilities, but Microsoft says it will add them soon.)

Inside a Panorama

Imagine a virtual environment in which you can view any portion of a 360-degree panorama—a wraparound photographic image of a real-world scene. You can pan the image left or right in a complete circle. Now add the ability to zoom in for a closer look at small details. You can examine selected objects in the panorama from any angle and even shift your position to other viewpoints, just as if you were actually there. Now imagine that you can achieve this virtual reality without any special gear except the computer on your desk. Apple's QuickTime VR and Microsoft's Surround Video, two similar versions of the new panoramic video technology, provide all this and more.

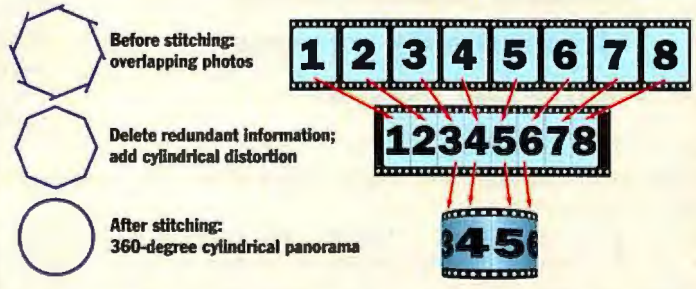
Navigating through a panoramic video is as easy as pointing and clicking with a mouse. The image on the screen represents a small portion of the entire 360-degree view—usually about 70 degrees, depending on the focal length of the lens used to take the original photos. To move your view of the panorama in any direction, you simply move the mouse cursor toward that edge of the screen. Horizontal panning is infinite in either direction; vertical scrolling is limited to the field of view captured by the camera's lens (more on this later).

To examine part of a scene at closer range, you can zoom to higher magnifications. The current state of the technology lets you magnify the image about two to four times. QuickTime VR automatically applies an antialiasing filter to smooth out the jagged lines caused by pixelation at these higher magnifications.

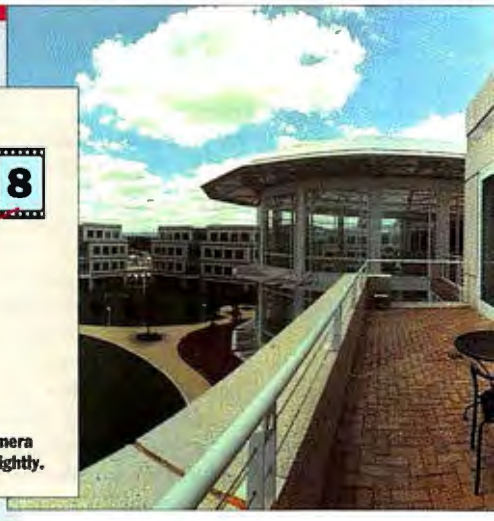
Most panoramas contain predefined hot spots that allow you to change viewpoints or examine certain objects in more detail. When you point at a hot spot with the mouse, the cursor changes to indicate what you can do. For example, if the developer linked multiple panoramas together, you could jump from one view to another simply by clicking the mouse on the appropriate spot. Another type of hot spot lets you "pick up" and examine certain objects from any angle. To enable this effect, the developer must photograph these objects separately and link them to the general panorama.

HOW APPLE'S STITCHER TOOL WORKS

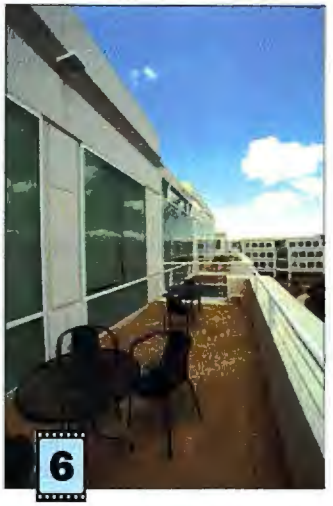
The QuickTime VR developer feeds digitized PICT files of still photos into the Stitcher program. Stitcher joins the photos together, eliminates redundant details between frames, aligns the edges, and applies cylindrical distortion to re-create the entire 360-degree scene as a continuous strip.



To shoot a panorama with an ordinary camera, the photographer must rotate the camera around the nodal point (i.e., the optical center) of the lens and overlap the frames slightly.











When you click on one of these objects, a special window opens on the screen, the object enlarges to fill the window, and you can rotate the image 360 degrees horizontally—and nearly as much vertically. This feature suggests all kinds of possibilities. For instance, a panoramic tour of a museum could allow you to pick up and examine artifacts that normally would be off-limits to visitors.

Apple and Microsoft are currently adding even more capabilities. Developers will soon be able to combine video footage with interactive environments by overlaying QuickTime or AVI (Audio Video Interleave) movies on panoramic backgrounds. Apple is perfecting an enhancement, called *localized sound*, that links prerecorded audio to your real-time video navigation. In one of Apple's demonstrations, you can scroll around a panorama of a beach scene. When a beach cottage comes into view, you can hear the faint sounds of voices. If you zoom in for a closer look, the voices become more distinct and combine with the sounds of a party. When you zoom back out, the sounds get softer again.

For Experts Only

Although viewing and navigating through a panorama are easy, creating one is a different matter. For now, the authoring tools and photographic skills required for this task are beyond the capabilities of most users. Someday these tools may become as easy to use as morphing programs, but until then, only the most advanced users and professional developers will be able to create panoramas.

The first step in the process is to shoot the pictures. This is where Surround Video differs significantly from QuickTime VR. Surround Video requires a special panoramic camera that rotates in a circle while continuously exposing a strip of film that moves in the opposite direction. In other words, instead of snapping a normal picture, the camera optically scans the image onto the film to make a strip that's about 7 inches long. (See the figure "How a Panoramic Camera Works" on page 88.)

QuickTime VR also lets you use a panoramic camera, but doesn't require it. Instead, Apple has sophisticated software tools that can assemble a panorama from a series of still photos taken with an ordinary camera. The key to this process is a program called Stitcher, which automatically joins the individual photos together to make a seamless 360-degree view.

No matter which kind of camera you use, the result is the same: an image with a very wide aspect ratio that encompasses a 360-degree view of the original scene. Apple does it with software, while Microsoft does it with hardware. Apple's approach offers more flexibility because you can take pictures with almost any camera, lens, or film format. (In fact, Apple has produced panoramas with inexpensive disposable cameras.) But Apple does *not* recommend using a still-video camera, such as the Canon RC-570, or a low-resolution digital camera, such as the QuickTake 100, or a frame-grabber with videotape. These devices don't deliver enough resolution to withstand magnification.

Shooting pictures for a QuickTime VR panorama is a bit tricky. First, the lens has to be of a rectilinear design, which includes most lenses for general photography, except for fish-eye lenses. The curvilinear







A panoramic camera, described at left, takes a 360-degree image on a single photograph. Above is a sample panoramic photograph of the Brooklyn Bridge.

images produced by fish-eye lenses won't work with the Stitcher program. Rectilinear lenses are designed to keep straight lines straight. (Apple recommends Sigma's 14mm f/3.5 and Nikon's 15mm f/3.5.) To include as much vertical space as possible, you should turn the camera sideways, even though this increases the number of pictures required to cover the 360-degree field. A 15mm lens is wide enough to cover that field in as few as eight frames, but Apple recommends shooting 12 frames of each scene to allow plenty of overlap.

When shooting these pictures, you have to rotate the camera around the *nodal point* (i.e., the optical center) of the lens. Otherwise, each frame will record a slightly different viewpoint, and the panorama will appear to jump when the user pans across the image. This is especially true if the scene includes objects that are close to the camera, because the parallax error between frames will be more obvious.

Unfortunately, tripod sockets are usually near the focal plane, not the nodal point. And the nodal point might not coincide with the physical center of the lens. To get around this problem, you need a special tripod head that makes it easier to visually identify the nodal point and adjust the camera's position. Apple is working with a manufacturer to produce one that is specially suited for QuickTime VR.

You can skip all this trouble by using a panoramic camera, which automatically rotates around a fixed nodal point. But such cameras have problems of their own. Only the most expensive models have interchangeable lenses, so you're restricted to a single perspective. These lenses are not very wide, so the vertical field of view is limited. And if you aren't careful, you might catch yourself in the picture.

To digitize the long filmstrip from a panoramic camera with enough resolution to support high magnifications, you have to use an expensive drum scanner that's big enough to accommodate the strip. Standard film scanners won't work, and flatbed scanners aren't recommended.

A Stitch in Time

The best way to digitize photos for a QuickTime VR panorama is to scan the film onto a Kodak Photo CD, which yields resolutions as high as 2048 by 3072 pixels at a color depth of 24 bits. That much resolution is overkill, however, and file sizes are large (more than 200 MB) when a dozen or more frames are stitched together.

QuickTime VR panoramas typically use the Photo CD base resolution of 768 by 512 pixels at 24 bits. If you stitch together 12 pictures, the resulting strip is a PICT file that's about 768 pixels high by 2496 pixels wide (after redundant information between frames drops out). Apple uses the Cinepak codec in QuickTime to compress this file down to a manageable 520 to 800 KB. (Surround Video panoramas are uncompressed and average about 1.4 MB, because on-the-fly decompression would impair playback performance.)

Apple's Stitcher program is mostly automatic, but it does require some intervention by the developer. Among other things, you must tell the program whether the camera was oriented vertically or horizontally and how much overlapping area between frames should be analyzed when the edges are joined together.

As long as those areas contain sufficient detail, Stitcher does a good job of matching the seams and eliminating redundant information. For example, if the right edge of one frame and the left edge of the next frame both include the same object—such as a doorknob—Stitcher can figure out that the object should appear only once in the panorama and deletes the overlapping portion. Stitcher also blends exposure differences between frames, so you can shoot the pictures at slightly different settings to maximize highlight and shadow details in different parts of the scene.

To align the seams, Stitcher applies cylindrical distortion across the entire image. This might appear counterintuitive—why shoot the pictures with a rectilinear lens if you're going to add distortion later? However, cylindrical distortion is necessary to produce a continuous, seamless image in which details along the frame boundaries match up perfectly (see "How Apple's Stitcher Tool Works" on page 86).

The result is a very wide image that's virtually identical to the cylindrically distorted filmstrip exposed by a panoramic camera. If you could join the ends of this strip together and stick your head inside the cylinder, you'd see an undistorted 360-degree view—which is exactly what the playback software does when it displays the panorama on the screen.

QuickTime VR and Surround Video can work with any digitized images, not just photos. If you'd rather create an artificial world, you can use a rendering program instead of a camera. You can also use an image-editing program to modify the panorama or combine photographic images with rendered graphics.

Finishing Touches

Once you have a panorama, the next step is to define the hot spots that link it to oth-



er panoramas (if any). Apple and Microsoft provide tools for creating these links. Apple's tool is a HyperCard program called Scene Editor. Using a standard paint program, you draw solid colors over areas of the panorama that will be hot. Each color marks a different hot spot, so they can be irregular shapes and noncontiguous. Areas that aren't hot are erased, yielding a white-background mask that Scene Editor links transparently to the panorama.

In addition to linking panoramas together, you can use Scene Editor to assign hot spots to objects. (Microsoft says it will add this feature to Surround Video, too.) QuickTime VR can display a magnified view of an object, and the user can rotate the image in any direction. Of course, this assumes the developer has already photographed the object from every angle.

This process requires about 500 images of the object. To make it easier to shoot these pictures with the proper alignment, Apple has a so-called bread-box rig that aims a camera along any angle at an object in the center of an imaginary globe. (The rig acquired its name because it accommodates objects as large as a bread box.)

The camera can shoot pictures while traversing imaginary latitudinal lines around the object. Each of the approximately 15 lines requires 36 pictures to cover the entire object. Since these close-up images don't require the high resolution of a panorama, they can be taken with a video camera and a frame-grabber—which is faster and more economical than shooting 500 pictures with a 35mm camera. Another QuickTime VR tool, Object Maker, converts these 500 views into a QuickTime movie file that the user can manipulate interactively.

The final step of the process is to package the panoramas, hot-spot masks, object views, layered movies, sounds, and other elements into a format that the QuickTime VR or Surround Video playback software can handle. Again, both Apple and Microsoft supply tools for this purpose.

QuickTime VR panoramas convert from PICT files to standard QuickTime MOOV files. During compression, the panorama is sliced into vertical strips measuring about 768 pixels high by 104 pixels wide. To reduce memory requirements, only part of the panorama initially loads into RAM. Additional strips load into memory when the user pans horizontally.

Surround Video uses a technique that is similar, except without compression. The panoramic file is called a *striped DIB* (device-independent bit map). It's much like a regular Windows BMP or DIB file, except the image is sliced into vertical strips measuring only 4 pixels wide. When the user pans left or right, the appropriate strips load into memory. Additional elements (e.g., movies and sounds) are stored in another new file type called an *asset database*, which is similar to a Macintosh resource file.

Developer Trade-Offs

Apple and Microsoft are taking very different approaches to their distribution of the authoring tools. Apple charges $2000

QUICKTIME VR VS. SURROUND VIDEO

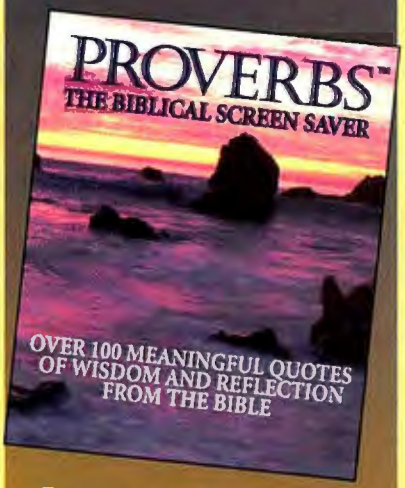
	QUICKTIME VR	SURROUND VIDEO
Displays on	Macintosh, Windows	Windows; Macintosh planned
Tools run on	Macintosh	Windows
Camera required	Any	Panoramic (expensive)
Magnification?	Yes	To be determined
Object examination?	Yes	To be determined
Costs	Kit, annual fee, royalties	Free to registered developers
Availability	Now	Spring 1995
Company	Apple	Microsoft

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for the QuickTime VR kit; this does not include the annual fee for becoming a registered developer. QuickTime VR authoring also requires HyperCard and MPW, which Apple includes in the package it sends to developers. Apple also charges royalties based on sales: 40 to 80 cents per unit, depending on the number of panoramas in the product. Apple's authoring tools are more sophisticated than Microsoft's, so Apple is obviously trying to get a return on its R&D investment.

QUICKTIME VR HARDWARE

For...	You'll need...
320- by 200-pixel resolution	68030 Macintosh
640- by 480-pixel resolution	40-MHz or faster 68040 Macintosh; PowerMac

Microsoft, on the other hand, sees Surround Video as a way to sell more copies of Windows 95 (which Microsoft recommends be used with it to obtain good performance). So, Microsoft is essentially giving away its tools by including them on the CD-ROMs periodically sent to registered developers. In addition, Microsoft doesn't plan to charge royalties.

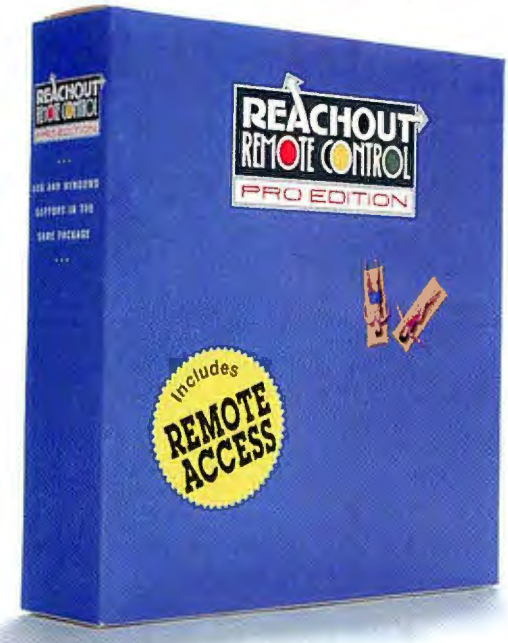
Because Microsoft requires developers to use a panoramic camera, however, it's more expensive to get started with Surround Video than it is with QuickTime VR. While a 35mm SLR camera and an extreme-wide-angle lens cost about $1000 to $2500, a good panoramic camera costs from $2500 to $22,000. Microsoft says that's an insignificant cost for professional developers, whose production budgets can range into the hundreds of thousands of dollars. Microsoft has also compiled an international directory of professional photographers who already have panoramic cameras; their rates average about $1500 per day, plus expenses.

Developers thus face a difficult choice: Either pay more for the authoring tools and royalties required by QuickTime VR or pay more for the photography required by Surround Video. Fortunately, users do not have to wrestle with these decisions. Although QuickTime VR is technically superior, Surround Video is not far behind. On the screen, both deliver a similar experience—a new way of viewing and interacting with virtual environments without the need for special equipment. ■

Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California, who has more than 20 years' experience in photography. You can reach him on the Internet or BIX at thalfhill@bix.com.

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- #1 Versatility
- #1 Ease of Learning
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★★★	7.5	Close-Up
★★★	7.3	Norton pcANYWHERE 1.0 for Windows
★★★	7.3	Carbon Copy for Windows

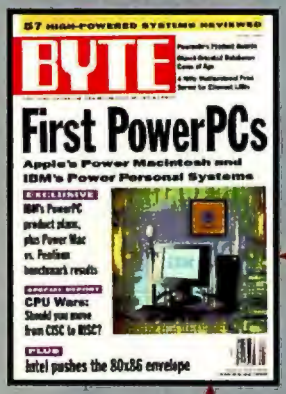
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BEYOND HOLLYWOOD



New tools and technologies make it easier to create professional-quality video and send it throughout your company

Digital video could be the next killer application if it weren't for the steep technical hurdles that have to be overcome to create, transport, and compress the medium. Nevertheless, some pioneering companies outside the professional video industry are using it to conduct business more efficiently and profitably.

New and less-expensive hardware and software for nonlinear editing brings professional-quality tools to within the budgets of the general-business community. Choices of ways to send video over networks are expanding. Lower-priced and higher-quality compression techniques make creating, storing, and sending massive video files practical. The stories that follow delve into each of these areas in detail.

But just solving technical problems isn't enough to solidify digital video's role for general business. Ten years ago, desktop publishing brought the graphics designer's tools to the masses, and ever since, we've been buffeted by the eye-boggling multitypeface memos created by design amateurs. As digital video moves into the mainstream, it will require the same learning curve as amateurs learn how to effectively use the medium. In its research into what attracts people to use interactive kiosks, IBM found that digital video can be both compelling and daunting: Video clips from 3 to 5 seconds long had a positive impact, but anything longer tended to lose kiosk users' interest.

Today's hottest video applications include video conferencing, distance learning, corporate training, and sales presentations, in addition to kiosks. However, expect it to be two to three years before digital video takes over most desktops. Emerging markets will remain key for now, because, as Paul Callahan, director of networking strategy at Forrester Research, Inc. (Cambridge, MA), explains, while compelling, digital video isn't critical yet to doing business for most companies. For video to become ubiquitous, hardware vendors must seed the market. "You've got to give it away," says Callahan. That process has already begun. Graphics chips vendors are introducing accelerators with on-chip motion video capabilities that will make 30 fps (frames per second) a throw-in item for Windows systems.

Even so, is digital-video production ready for prime time? To find out, we rolled up our sleeves and created our own digital-video project. "BYTE's Video Workshop" recounts our experience and offers some surprising insights into what video nonprofessionals will need in terms of hardware, software, time, and expertise. Technology may soon bring video to a screen near you, but creating it remains an art. ■

—Alan Joch, Senior Editor

BYTE's Video Workshop
Peer under the hood to see how to make an actual video product. We'll show you how to do it right, and what traps to avoid 97

Compression Scorecard
Compression got you confused? Here's how the major compression/decompression schemes stack up against each other 107

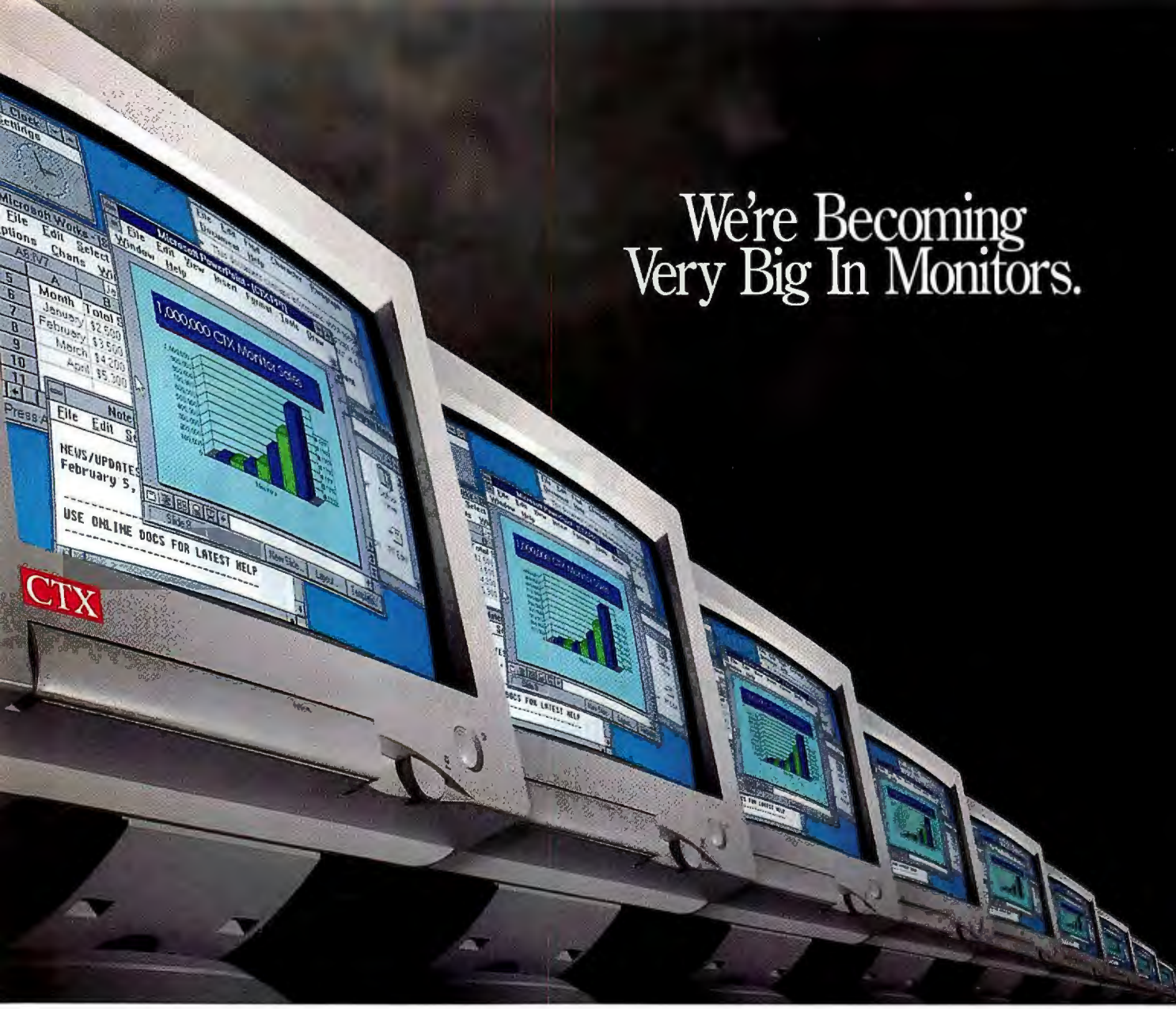
Video Connections
Isochronous Ethernet and ATM square off in the battle to become the standard for sending video across networks 113







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BYTE's Video Workshop

Is it practical to create video products in-house? Yes, but be prepared to spend an enormous amount of time trying to get the different hardware components to talk to each other.

STANFORD DIEHL



LANCE JACKSON © 1995

The Digital Video Revolution has arrived, but don't expect a lot of fanfare: Everyone's too busy getting the hardware to work. In the age of MTV and sound-bite presidential campaigns, video's power is obvious, but capturing video at the PC desktop and delivering it across the enterprise is still fraught with the glitches and the gotchas of the PC architecture.

That's no reason to let the revolution pass you by. Digital video is essential for producing CD-ROM-based products that can hold in-house training programs, presentations, and other types of corporate data. Digital video excels at handling small video segments like these, and with CD-ROM players on many desktops, it's often easier to view a CD-ROM in the workplace than a VHS tape.

Over the next several months, expect an explosion of motion-video hardware, mainstream playback boards, and turnkey capture solutions to hit the market. When Windows 95 finally ships, it will provide an integrated multimedia architecture along with 32-bit versions of the Indeo and Cinepak codecs.

What's more, almost every major graphics chip vendor—including S3, Tseng Labs, Western Digital, and Brooktree—has or will soon release a Windows accelerator that incorporates on-chip motion-video acceleration. This, along with the new DCI (Display Control Interface) drivers, will make full-motion video a standard capability of most Windows accelerators (for a review of hardware video architectures, see "Video for Free," February BYTE).

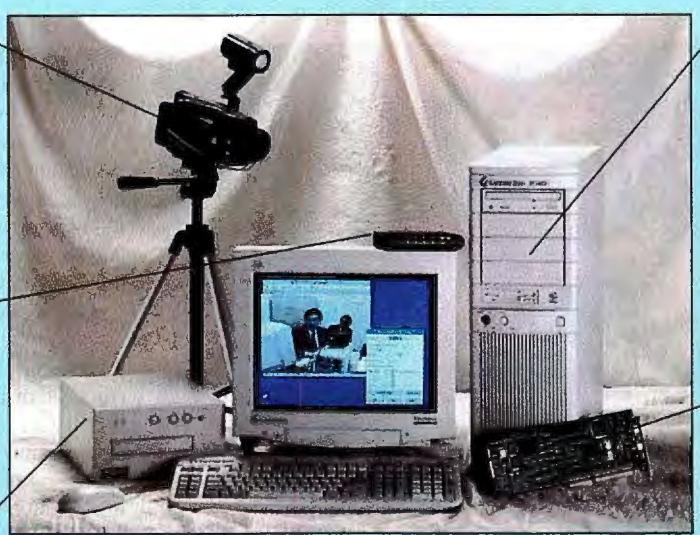
BYTE set up a desktop video production suite and created an in-house multimedia product to find the requirements, the problems, and the issues of desktop video production. We looked at video from the corporate perspective rather than the professional broadcast angle. Without contracting professional video services or

What It Takes

DIGITAL VIDEO

TOTAL COST: $12,700

Digital video works best when the output medium is a CD-ROM or hard drive. The video segments should be relatively short and launched from interactive buttons. Among digital video's advantages are nonlinear editing and playback, a broad range of Windows editing tools, and a wide variety of digital video effects to choose from. The mainstream emergence of MPEG promises to improve quality and expand playback windows to half-screen or full-screen. And while the resource requirements of digital video can reach astronomical proportions, they are scalable: You can start experimenting with a $700 capture board (like the miro shown here), your current PC, and a consumer camcorder.



The Sony CCD-TR700 Hi8 Handycam camcorder. S-Video and composite video jacks, LANC connector, and color viewfinder ($1100).

Consumer Technologies' Presenter3 Computer-to-Video scan converter ($349). (For comparison purposes, we used the Scan Do Pro pricing, listed in "Analog Video," for both setups).

Gateway P5-100XL, a high-end Windows system ($4400) with:
- a 100-MHz Pentium
- 32 MB of RAM
- a 2-GB hard drive with PCI-SCSI controller
- a quad-speed CD-ROM
- 16-bit audio
- 24-bit video and a 17-inch monitor

miroVideo DC1. Video capture and Motion-JPEG compression board ($700). (Not included in total cost—MPEG station comes with capture board).

The MPEG Creation Station ($4699). Smart and Friendly's bundled solution includes all the hardware and software components you'll need to create MPEG titles from the desktop:
- Fast Electronic's MovieMachine Pro video capture board
- Smart and Friendly CDR-2000 CD Recorder (shown here)
- Macromedia Director and Authorware Professional
- Xing MPEG encoder software
- Fast Motion-JPEG daughtercard
- Autodesk Animator Pro
- Adobe Premiere for Windows
- Gear CD-R software

hiring a video specialist, can a corporation build video production capability on the PC desktop?

The answer, we concluded, is yes. But in the process, we ran into one configuration hassle after another trying to mix together the various components, such as a 24-bit Windows accelerator, a motion-video capture card, a hardware compression module (often a separate card requiring a unique interrupt and address), a 16-bit sound card, and a CD-ROM drive or CD-ROM recorder.

We also learned that while digital video may be all the rage today, you need to look past the hype. Analog video can be a better solution if VHS tape will carry your message from the president, customer profile, or other long-length subject. For details, see the text boxes "What It Takes" and "Analog, Hands On."

BYTE Video Productions

Our video workshop started with the idea of capturing the valuable technical information that companies present to BYTE each day in product demonstrations. We set up cameras to record the give and take among industry representatives and BYTE editors. We trained one camera, a pro/am-level Sony Hi8 Handycam, on the main presentation speaker. The second camera, a professional-class Panasonic Omni-MovieHQ SuperVHS, filmed a wide-angle shot of all the demonstration participants. A scan-converter piped the on-screen computer presentation to a Sanyo Super-VHS tape deck. The tapes that resulted held a treasure of industry insights, demonstrations of exciting new products, and unguarded revelations of limitations and bugs.

We planned to send the edited video package to editors in our worldwide bureaus, to freelance authors, or to anyone else who needed the information. The target market drove not only how we scripted the content but also the development platform. We chose two different output targets: analog videotape and digital video on CD-ROM. The text box "What It Takes" shows our digital-video and analog-video production platforms.

CD-ROM products work best for nonlinear delivery of information. You click buttons on the CD-ROM title's interface to launch short video clips (see the screen on page 100). We broke our video content into several clips and organized them by subject. Click on one button, for instance, and you can see a selection of sample video transitions shown in one vendor demonstration. These video clips played samples of transitions and on-screen

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ANALOG VIDEO

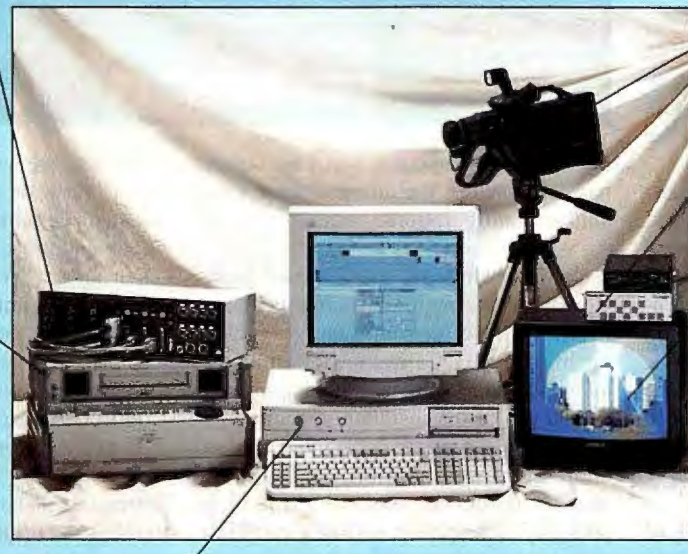
TOTAL COST: $17,200

Analog editing works best when the output medium is VHS tape and the content is long-length videos such as speeches and customer testimonials. Analog production avoids many of the headaches associated with digital video. There are no quality degradations or performance issues surrounding video compression because analog production requires no compression. And with analog video, VHS tapes are, in effect, your storage medium, so you avoid the eye-popping hard drive requirements of digital capture and edit. Video Machine doesn't demand memory beyond what you need for traditional Windows applications because the digital effects are processed in on-board frame buffers. Total cost (for both systems) includes $500 for cables, tripods, lighting, and other expenses.

Video Machine Lite from Fast Electronic. Along with Matrox Studio, it is the leading analog video-editing platform for Windows. An internal board is installed in the computer. Shown here is the optional Studio Control Box ($2495). The same functionality is available with VM Lite and the Multi I/O cable ($2995).

Two Sanyo GVR-S955 SuperVHS decks. For true A/B roll editing, you'll need three decks, but if you don't mind shuffling tapes, you can get away with two ($3495 each). For desktop video applications, your deck should support:

- Computer control
- SMPTE time code
- S-Video I/O
- SuperVHS
- DCI drivers
- Drivers for Video Machine (or selected analog control system)



Panasonic OmniMovieHQ SuperVHS camcorder. S-Video and composite ports ($1600).

Scan Do Pro. Computer-to-Video scan converter for capturing computer screen to analog tape. From Communications Specialties ($1995).

13-inch Sony Trinitron monitor with composite inputs and a video sequencer to monitor the various video sources ($600). This is a low-end solution. Alternatively, we used Sampo's new AlphaScan LC, a beautiful 20-inch monitor with two VGA inputs, a composite video input, a stereo audio input, and a cable TV input with tuner. You use remote control to switch among video sources.

The Video Machine does not require a high-end system. We used a Gateway 486/66 with 8 MB of RAM, a 500-MB hard drive, PCI video, and a 17-inch monitor ($2500).

tutorials on how to create the transitions with a selection of digital-editing software.

Capture Conflicts

To digitize our taped demonstrations, we first used the Orchid Videola Premium. After trying almost every configuration combination imaginable, we got the video capture working—or so we thought. When we dumped the captured clip into Adobe Premiere (our editing software), the video was consecutive frames of solid pink.

Orchid technical support came up with a solution: Go into Gateway's BIOS setup and disable BIOS shadowing. That trick let us capture some excellent video clips using Orchid's Motion JPEG compression (an optional daughtercard is required for M-JPEG).

Unfortunately, the Videola requires a VGA feature connector, which limits your desktop resolution to 640 by 480 pixels. (In theory, you should be able to get up to an 800- by 600-pixel resolution desktop, but we never got stable output at the higher resolution.) Adobe Premiere and other digital video editors present a full desktop with an assortment of tool palettes and windows. You also must work with a time line packed with video strips, transition effects, and audio waveforms. It's simply too much interface for anything less than a 1024- by 768-pixel resolution desktop.

Many alternatives can replace the feature-connectors (faster local-bus architectures such as PCI [Peripheral Component Interconnect], better compression schemes, integrated chips that combine Windows acceleration with motion-video support, and architectural solutions such as VESA Media Channel). At this point, we don't recommend a feature-connector solution.

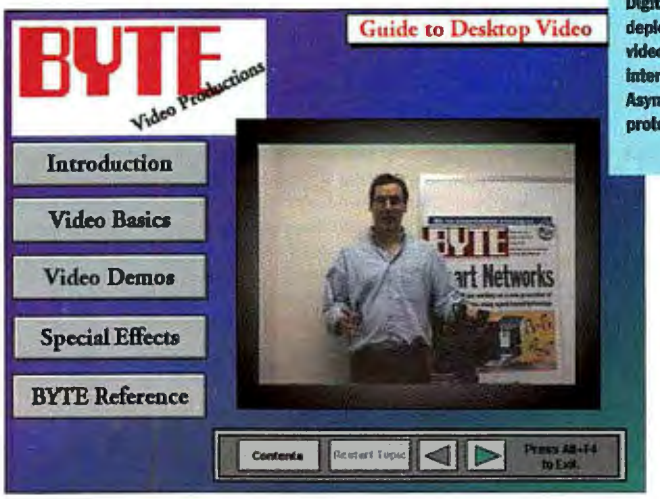
The best answer is a turnkey solution. We solicited Smart and Friendly's MPEG Creation Station, a well-conceived bundle of products that comprises all the pieces you'll need to generate MPEG titles. Smart and Friendly offers the MPEG Creation Station as a turnkey system, but when we started our project, the components were only available separately. That's a lot of stuff to get working in a single PC.

We ran into problems trying to get the Fast Movie Machine to work (the capture component of the MPEG Creation Station). The Movie Machine supports an optional Motion-JPEG board that occupies its own slot, interrupt, and address space. When we first installed it, the motion-video input displayed on screen, but it wasn't aligned in the capture window. When we tried to load the alignment controls, we were unceremoniously

bumped out of Windows. A few configuration options later, we got the video capture to work well, but when we played back the captured clip, compression didn't work properly. We finally resorted to a second machine, but it didn't work either.

Vendors and developers in the digital-video field told us conflicts are normal. We heard plenty of other horror stories, usually solved by a technical-support engineer who knew the vagaries of the specific combination of hardware components. Here are a few tips:

- Keep a good configuration log. Write down the interrupts and addresses occupied by each component in the system, and keep track of which combinations have failed.
- Get to know MSD (Microsoft Diagnostics), the configuration utility that ships with DOS. It can return valuable information about open interrupts and addresses.
- Get the capture and compression component working first, before adding sound cards, CD-ROMs, and network interfaces.
- Plug the network card in last and use the 3Com EtherLink III, if possible. It shipped with our 100-MHz Gateway. It's the closest thing to true plug-and-play that we've ever run across.
- Install VFW (Video for Windows) 1.1d and keep your software setup routines from reinstalling VFW run time (if possible). Some installation software will overwrite your current VFW drivers and downgrade you to an older version. It happened to us more than once. VFW 1.1 is a significant upgrade from 1.0, and you'll need it.
- Call technical support *before* you lose your wits or kick your dog. Have your log handy so that you can report your current hardware setup, including interrupt and address configurations.



Digital Video is best deployed by launching small video clips from a CD-ROM interface. We used Asymetrix's Compel to prototype our video project.

Andrew Hudson, president of North Coast Software (makers of the PhotoMorph video-effects package), suggested the miroVideo DC1 capture and compression card. His company was happy with it, and the card's installation routine automatically senses available interrupts and addresses—well, sort of. Configuration glitches remained. Without a true plug-and-play architecture, software can't reliably find the best configuration options, but the miroVideo performed better than most. The bottom line is it worked reliably with all our other hardware.

The card captured video through the S-Video port without dropping any frames, and it supported high-quality Motion-JPEG compression on-board (the compression hardware didn't require an additional board or daughtercard). For us, the miroVideo was the solution.

Video Assembly

Finally, it was time to capture video (see the text box "Capture Tips"). We had filmed two hour-long demonstrations, and we had three tapes of each session: one wide-angle view, one zoom of the main demonstration presenter, and one video capture of the demonstration computer screen. We captured short video clips from the assembled content. We quickly realized that the 500 MB free on our 1-GB hard drive would not suffice; thus, we installed Adaptec's PCI SCSI Master drive controller and a fresh Micropolis 4110 1-GB drive before proceeding. For your video-capture station, 4 GB is not an unreasonable recommendation, and if you really want optimum performance from a storage system, invest in one of the high-capacity audio/video hard drives, which are optimized for multimedia applications.

On the surface, you can capture raw video as easily as plugging your video source into the capture card and firing up your capture driver. But for optimal playback on target systems, you need to consider many performance issues.

VFW will drop frames from a video clip if the playback system can't keep up. Your video clips will look better on your target systems if you select a capture rate that your target hardware can handle. It is better to run a video at 12 fps without dropping frames than to play it back at 15 fps with dropped frames. A lower frame rate stretches the display of each frame, smoothing out the overall playback quality. Dropped frames result in extremely jerky motion. So select the highest frame rate that your target system can play back without dropping frames.

Here's the rub: Playback on any system can achieve only the maximum frame rate you've configured for your captured sequence. If your capture rate is at 12 fps, the quality will look the same on a 33-MHz 486 as it does on a 90-MHz Pentium

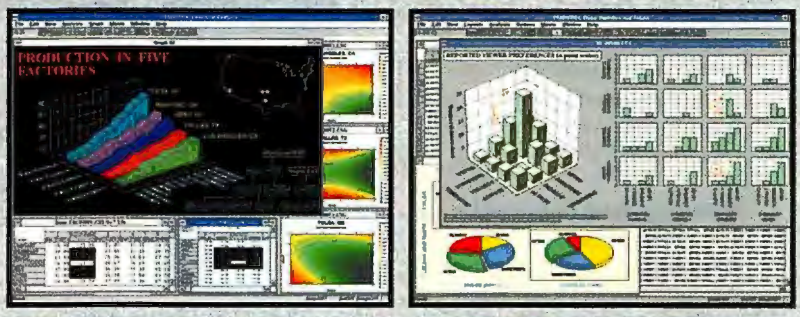
Capture Tips

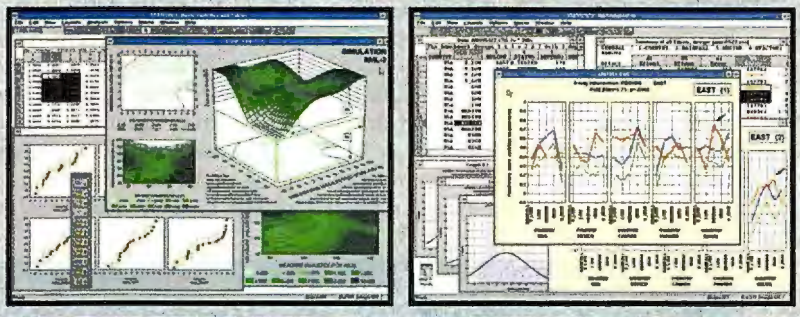
- Compress at the highest rate that your target system can play back without dropping frames
- Capture at the highest possible rate and then recompress to the target rate
- Select the driver's VCR checkbox to enable time-base correction
- Make sure your hard drive is large and fast (1 to 4 GB and 6-Mbps sustained data transfer rate)
- Capture at 160 by 120 pixels if your target systems support hardware scaling
- Use step-frame capture if your video source supports it
- Compress with Indeo 3.23 for software-only playback
- Develop with MPEG if your targets support MPEG playback

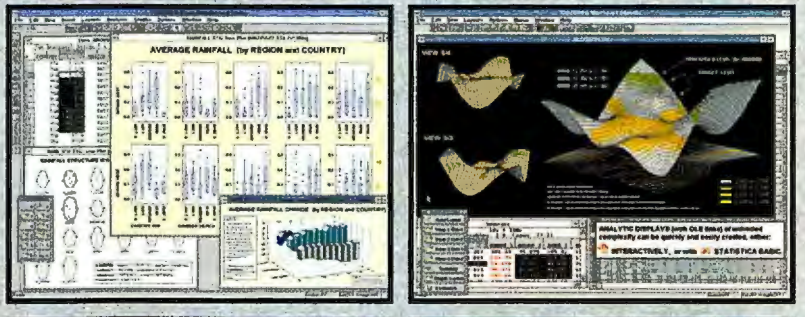
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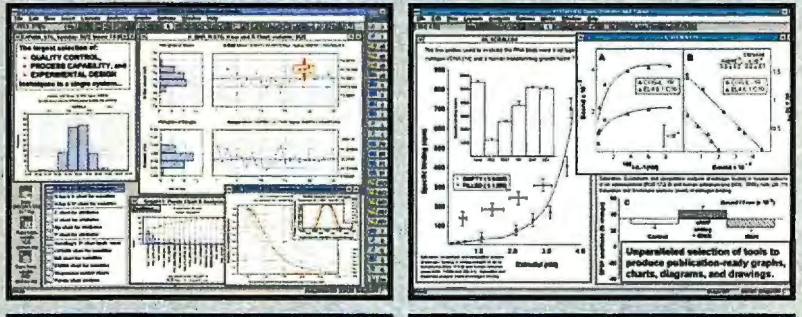
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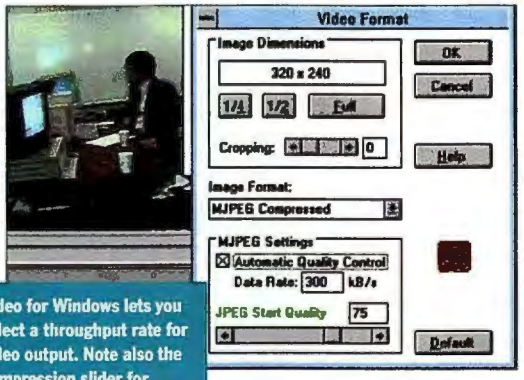
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with a motion-video accelerator. If you up the frame rate, you degrade playback quality on your low-end target; lower the frame rate, and you waste any special playback acceleration at the high end. MPEG solves the problem with dynamic frame rate support, but your target systems will require MPEG decompression hardware. We'll address those issues in a moment. First, let's look at VFW.



Video for Windows lets you select a throughput rate for video output. Note also the compression slider for output quality.

Optimizing Video Compression

To optimize frame-rate and compression parameters to a targeted throughput rate, start from your VFW capture driver. As you can see from the screen above, VFW gives you some important output options. First, you can select a target throughput rate. If your target is a single-speed CD-ROM drive, select a throughput rate of 150 Kbps. You can also adjust the compression quality. Start at 100 percent quality and scale it down if you exceed your targeted throughput rate. It will take trial-and-error to tune performance properly. Luckily, you can capture your original video sequence and then save it with different parameters (using the VFW driver "Save As" option).

Normally, you should avoid recompression because each compression pass results in some quality degradation. But most boards use only intraframe compression during capture. Recompression to a lower frame rate takes advantage of intraframe and interframe compression, improving overall quality. (For more compression details, see the article "Compression Scorecard" on page 107.)

A Step at a Time

To avoid quality degradation in real-time video capture, you could install at least 64 MB of memory and capture small clips directly into RAM. A more practical way to avoid real-time compression is with *step-frame* capture. Here, your capture driver receives the first frame of the video clip from the video source. The driver then compresses the frame, taking as much time as it requires. After compressing the frame, the driver advances the video source one frame and begins processing the next image. Step-capture rates are often specified in a ratio; for instance, a

Analog, Hands On

VM (Video Machine) from Fast Electronic was the core of our analog-video production platform. It consists of a single hardware board that slides into a 16-bit PC slot. An output cable splits into multiple connectors to accept external device signals. The separate VM Studio Box supports additional ports and makes it easier to hook up devices.

VM hardware installation was surprisingly easy. After placing the jumperless VM card into our Gateway 486/66, we booted the auto-sensing drivers that checked for available interrupts and memory addresses. The Sanyo decks fed the VM Studio Box through a serial connection (for computer control) and an S-Video cable (for the video signal).

We then loaded the software application and selected the VM-supported decks from the Device Setup option. We stayed with the driver's default options (except for changing the video format from PAL to NTSC), defined the I/O ports, and designated one deck as the player, the other as the recorder. The Sanyo decks let us stripe SMPTE time code onto SuperVHS tapes that already contained video content. Time coding helped us determine precise frame positioning.

Let It Roll

To create your video product, you designate certain portions of the tape and lay them out on a time line, much as you do with a digital editor like Adobe Premiere. But the software application only retains the pointer information to the analog tape sequence. We marked the appropriate clips from both sources and placed them on the time line. We then dropped transition effects between clips. Video Machine captures the last frame from the "A" clip and the first frame from the "B" clip and stores the frames into its on-board frame buffers. The transition is then created digitally from the two frames. Because of these digital effects, Fast refers to VM as a "hybrid" rather than an "analog" system.

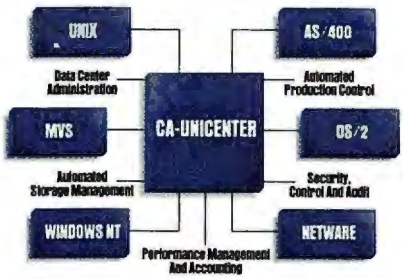
Once the clips are marked and laid out, we told the Video Machine to compile the final production and record it to our destination deck. The software locates the mark-in and mark-out points of each clip (using SMPTE time code) and outputs the clip to the destination recorder. The digital transition is then output to the recorder, and the next clip is retrieved from the analog source. In this way, Video Machine compiles the edited production from two (or more) sources and applies transitions and effects. In addition, you can overlay images from your hard drive or generate titles and overlay text from any Windows application.

If you have a true A/B roll configuration (requiring three decks), the final compilation can be hands-free. You put one video source in the "A" deck and the other source in the "B" deck and let it roll. We had only two decks total, so the process was not as automated. We had to feed the proper VHS tape into the input deck each time there was a transition from one reel to the next, but the final product came out as smoothly as it would have with a real A/B setup.

If you want to create in-house VHS videos of staff meetings, speeches, and demonstrations, the Video Machine solution is the best way to go. Video Machine supports all the standard transitions and effects you'll need for a corporate production, and the production process is much more streamlined than if you tried the same type of product using digital video.



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20-to-1 compression rate requires 20 minutes to process 1 minute of real-time video. Use step-capture if you have the hardware and software to support it (you'll need a deck or a camcorder that your driver can control through MCI (media control interface). An emerging standard for device control is LANC, a protocol for controlling consumer devices remotely. When you're shopping for a consumer or "prosumer" camcorder, look for a LANC connector. Our Sanyo deck shipped with an MCI driver for computer-control through the serial port.

Microsoft and other vendors are addressing MPEG's incompatibility problems by standardizing on an MPEG implementation that will be incorporated into MCI. MPEG uses bidirectional interframe compression (an intermediate frame can refer to the previous key frame and to the subsequent key frame to optimize compression), a capability not supported in VFW. So in the immediate future, MPEG can't plug into VFW as an installable codec. You'll have to implement MPEG via MCI calls. But that's not a major roadblock. The VFW Developer's Kit ships with a Visual Basic Custom Control for accessing MCI devices from Visual Basic programs. In fact, building a simple Visual Basic–based interface for corporate video delivery is fairly easy to design and implement.

With MPEG, you'll be able to dynamically adjust the playback rate, sending 30 fps to a hardware-assisted target or delivering only key frames to a low-end platform. And, of course, MPEG can take advantage of DCI by passing unscaled YUV (shorthand for broadcast signals that define luminance, hue, and saturation) data to an available DCI-enabled video accelerator.

For practical advice on optimizing compression for video playback, see Jan Ozer's excellent book, *Video Compression for Multimedia* (Academic Press, 1995). It is full of good tips and tricks, and it also comes bundled with Doceo's VCS (Video Compression Sampler), an invaluable tool for optimizing video compression and playback. VCS displays a video clip's throughput rate so that you can easily see how well your clips conform to a throughput target. You can even pinpoint specific frames where your compression is breaking down.

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Post-Processing

We found some outstanding software tools for editing our digital video clips. Adobe Premiere 4.0 is an obvious choice. PhotoMorph can create slick digital transitions and dump the results to an AVI (Audio Video Interleave) file. You can then drop the clip directly into Premiere or any other tool that supports the AVI format.

Star Media Systems recently began shipping a remarkable editor called Video Action Pro. This first release offers tools for video editing, animation, digital effects and transitions, filtering, chroma-keying, audio mixing, and title generation from a single interface. Very impressive.

With all this software power, it's easy to get carried away with special effects. For corporate video production, stick to the basic transitions: hard-cut, dissolve, and a few selected wipes. Don't use effects or transitions just for their own sake. Each technique should serve a clear purpose that's related to the content of your project.

That's a Wrap

Our video project still needs a nip here and a tuck there. We've captured key clips and created a prototype interface, but we still have to toil with authoring environments and spit the results out to our CD-ROM recorder. For now, we have our capture station producing high-quality digital video.

We believe in-house video production is viable for corporate content. Although you still need professional video services for broadcast-ready production, such as TV advertisements and public-relations promos, desktop video is effective for training and other corporate-video content. But it isn't yet Plug and Play. You'll need computer-savvy people who, preferably, have also dabbled in video. In the ramp-up phase, you might even need an outside consultant, but once you're up and running, the payoff can be significant. Video is an effective way to distribute information. Welcome to the revolution. Stay tuned. ■

Stanford Diehl is director of BYTE Reviews and aspiring creative director of BYTE Video Productions. Previously, he designed computer-based training courses for a major industrial contractor. He has been installing, configuring, and testing computer hardware and software for over 10 years. You can reach him on the Internet or BIX at sdiehl@bix.com.

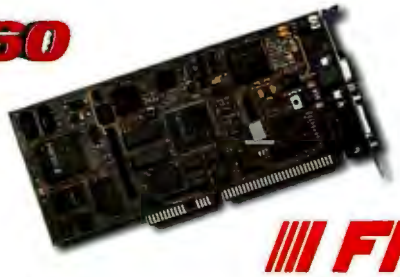


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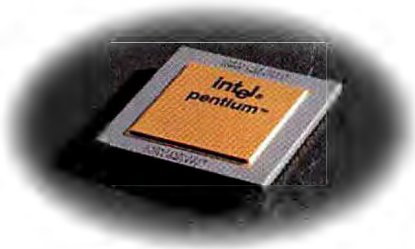
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COMPRESSION SCORECARD

Confused about compression? Here's how the leading codecs stack up for speed and image quality.

JOHN BRYAN



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Video compression is like life: It's impossible to be too thin or too rich. In the video world, crash diets and wealth take the form of new algorithms that reduce video to its essence but keep it looking as rich as the original image. Packing video data tighter means it will look more realistic when its played back on affordable video hardware, or better yet, on the same hardware that's sitting on our desktops crunching data and processing words.

A number of compression schemes exist, each with its strengths and weaknesses. For example, just because Radius's Cinepak shines for high-motion video clips, don't expect it to be tops for a low-motion "talking-head" clip; image quality is sharp and few codecs (compressor/decompressors) work better than the venerable Video 1 when images change little from frame to frame.

Video compression is vital to anyone using digital video, whether you're a developer of CD-ROM titles and videoconferencing systems or a creator of corporate presentations and training tools. The codecs you choose for each project will determine how good the images look and how smoothly they flow when your audience watches them.

Compression Camps

Compression methods fall into camps. Some rely entirely on software codecs, and others use a combination of software and dedicated processors. Hardware-assisted compression algorithms have one terrific advantage over the software approach: speed. Plug in an MPEG board, and you can decompress video at the same rate and image quality as that of a VCR tape. Besides high cost, the downside to hardware-assisted compression is you gamble that all the potential viewers of your MPEG-compressed video will have the proper MPEG decoder on his or her machine.

What's the benefit of the software approach? Cost. Some leading software codecs come bundled in products like

COMPRESSION QUALITY

To reflect real-world use, we compressed MPEG images at 30 fps (frames per second) at a data rate of 150 KBps; all others were 15 fps at 290 KBps. This means the upper-right MPEG example compressed four times more data, which accounts for the blurriness. The lower-right box compares a software-only and an expensive hardware-assisted MPEG codec.



Cinepak

Software-only, uses vector quantization. Originally developed by SuperMac Technologies, now owned by Radius.

ADVANTAGES

Supports a wide range of platforms, including Windows and the Macintosh. Part of Video for Windows and QuickTime codec libraries. Uses a palette of 16.7 million colors.

DISADVANTAGES

Dithers to simulate colors in 8-bit mode. Host computer's processor and bus type determine performance.

APPLICATIONS

For high-motion video, among the best overall quality and fastest performance, although Indeo 3.23 is only slightly slower. Not as sharp as Indeo for low-motion video. Works best for 320- by 240-pixel displays, quality degrades at the lower resolutions. Fuzzy images mean it's not the best option for animated sequences.



Indeo 3.23

Intel's vector-quantization software-based descendent of DVI. Compression technology for Intel's videoconferencing products. Can handle DCI adapters. Version 4.0 planned for later this year.

ADVANTAGES

Palette uses 16.7 million colors. Supports Windows, Macintosh, and IBM's Ultimedia OS/2 R2.1 and Video In. Part of Video for Windows and QuickTime codec libraries.

DISADVANTAGES

Dithers to simulate colors in 8-bit mode. Host computer's processor and bus type determine performance.

APPLICATIONS

Among the best in performance and quality for high-motion video. Performs well on low-motion videos at virtually all resolutions. Better palette handling in 8-bit mode than Cinepak. Indeo is best choice when working with resolutions lower than 320- by 240-pixels. Fuzzy animations.



MPEG

MPEG-1, MPEG-2 (currently used primarily by the broadcast industry), and MPEG-4 (for video telephony) developed by the ISO Motion Picture Experts Group. Based on lossy asymmetric compression algorithms. Designed to be played back with dedicated hardware, although software-only playback products are starting to appear.

ADVANTAGES

Produces VCR-quality video at full-motion (30 fps) rates. Can achieve a compression ratio of up to 200:1.

DISADVANTAGES

Hardware-based playback limits distribution to suitably equipped computers. Not a Video for Windows codec.

APPLICATIONS

Limited-distribution applications where playback hardware is known and sharp image quality is important (i.e., training, presentations, and kiosks).



Truemotion S

From Horizons Technology, uses a scalable algorithm that runs under Video for Windows. Software only. Capable of 640- by 480-pixel video at 30 fps on Pentium-class systems, although performance on 486s is much slower. Supports Windows, DOS, and Macintosh.

ADVANTAGES

Can run at resolutions and color depths higher or lower than the original.

DISADVANTAGES

Performance is dependent on the host processor and bus type.

APPLICATIONS

Scalability makes it suitable for a range of applications, from mass-market CD-ROM titles to high-end uses, such as sending multimedia over LANs.



Video 1

Software-based, part of the Video for Windows codec library. Originally developed by Media Vision, now owned by Microsoft. Uses the proprietary Motive technology for intraframe compression.

ADVANTAGES

Doesn't dither in low-color settings.

DISADVANTAGES

Lower quality than Indeo and Cinepak. Breaks up in high motion.

APPLICATIONS

Mass-market multimedia products and low-end machines. Works best for low-motion video sequences and animations.





XingCD **MPEG**

XingCD is a software-based MPEG compression program. Image on right was compressed with FutureTel's PrimeView II, a $17,000 hardware-assisted MPEG codec.

ADVANTAGES OF XINGCD

Performs MPEG compression with conventional processors, such as a 486 or Pentium. The $995 price is low compared to MPEG codecs using dedicated processors (which cost from $2000 to over $50,000).

DISADVANTAGES OF XINGCD

Not Video for Windows compatible. Compression takes 10 to 100 times the length of playback time.

APPLICATIONS FOR XINGCD

Multimedia CD-ROM developers.

Note: Quality samples and test-result interpretations were derived from the video compression sampler by Jan Ozer, author of "Video Compression for Multimedia" (Academic Press).

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Microsoft's Video for Windows, or you can download them from a BBS. Also, the performance inferiority of software codecs is fading as Pentiums, Power Macs, and local-bus systems become the norm. The easy distribution of software codecs increases the chances that your intended audience will be able to view your video product.

View Before You Choose

For more comparative information about codecs, consider Doceo Publishing's Video Compression Sampler. This $99 CD offers side-by-side playback capabilities for a number of software codecs. The sampler includes video test files. The program keeps statistics about key frame settings, frame rates, compression quality, and average data rate for each codec. Doceo is at (404) 876-8954.

How It's Done

Most compression algorithms divide a video frame into blocks and then look for redundant data. This is known as *intraframe* analysis. In *interframe* analysis, algorithms make the same kinds of comparisons between frames. The algorithms then drop redundant data to reduce the overall size of the video file. This technique is called *lossy* compression, and it's used by all the major video codecs. In general, the more you compress a frame or data stream, the more losses there are. The trick is to balance the compression ratio with the resulting image quality.

Codecs may be either *symmetric* or *asymmetric*. A symmetric algorithm uses an equal amount of time for compression and decompression and is common in real-time video capture in such applications as videoconferencing. Asymmetric codecs take more time in the compression stage to try for the highest level of belt tightening possible and work best for presentations or CD-ROMs.

Once a codec saves the nonredundant data, it statistically processes the arrangement of pixels in an image. These statistical data arrangements become encoded with an RLL encoding scheme or an equivalent, with shorter codes assigned to repetitive data.

The codec then may use a variety of compression methods. Two popular ones are *DCT* (discrete cosine transform) and *VQ* (vector quantization). Both use wave equations or a similar mathematical concept. The frame is divided into blocks, generally 8 by 8 pixels each, and the transform mechanisms work on the individual blocks.

DCT converts pixel intensities to a frequency-based equivalent. The transform yield is a series of numbers that represent ever-finer detail in a pixel block. Compression comes by eliminating the representative numbers after a certain point in the series. The result is a loss of fine detail, but ideally that level of detail won't be detectable. MPEG codecs use DCT.

VQ uses vectors to select predefined equations. Codecs can tune quantization so that block color and intensity are handled differently on a discreet basis and in relationship to the surrounding image values. Both Cinepak and Indeo use VQ for intraframe compression. One benefit of the VQ algorithm is that it is based on a table

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0 1 2 3 4 5 6 7 8 9

[1] Average score of six Pentium-90 systems.

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State of the Art Compression Scorecard

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Indeo 3.23 .... Free to developers
Intel
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Truemotion S
$.50 per CD or 2 percent of revenue (whichever is higher); $5000 prepaid royalty required. Corporate site license of playback software: $25 per PC (100 PC minimum).
Horizons Technology, Inc.
San Diego, CA
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fax: (619) 292-9439
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Video 1
Part of Video for Windows bundle, not sold separately.
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XingCD $995
Xing Technologies Corp.
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comparison process to provide fast performance on high-end 486s and Pentiums.

Other less widely used compression methods exist beyond DCT and VQ, including fractal-image compression, a proprietary technology developed by Integrated Systems' Michael Barnsley (for details, see "Fractal Image Compression," October 1993 BYTE). An enhancement of the still-image JPEG standard, M-JPEG (motion JPEG) compresses every frame individually for high image quality.

The result of the transform process is then compressed via RLE (run-length encoding). Codecs compress these bit strings even further by scanning the patterns at a different angle and converting the values to RLA (run length/amplitude) tokens. Huffman coding then converts the most frequently occurring tokens into the shortest bit strings.

Codecs use these compression transforms for intraframe compression. Interframe compression is largely a subtractive process that a general-purpose CPU can handle.

Microsoft and Apple, with Video for Windows and QuickTime, respectively, influence the compression world, although they don't specifically provide their own codecs. The AVI (Audio Video Interleave) format in Video for Windows provides a standard file format for developers. Video for Windows includes Cinepak, Indeo, and Microsoft's RLE and Video 1.

QuickTime for Windows and QuickTime for the Macintosh support Indeo, Cinepak, and MPEG decompression boards. QuickTime for Windows files and Video for Windows files aren't compatible.

How to Choose?

To pick a codec, first decide if your audience is likely to have dedicated video hardware or general-business computers. Then select an appropriate resolution and color depth, depending on the subject of the video. Finally, process your video with a variety of codecs to compare image quality. With your eye as the final judge, your video files should be both thin and rich with impact. ■

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VIDEO CONNECTIONS

True believers say isochronous Ethernet will bring digital video to the desktop sooner

JEFFREY FRITZ



LANCE JACKSON © 1995

In March, the IEEE was scheduled to vote on specification 802.9a, which outlines the technical underpinnings of isochronous Ethernet, a technology that for a small but determined group of companies is currently the best hope for easily sending digital video and audio across a LAN. Its proponents, including National Semiconductor, the company that developed the technology, say digital video is available to anyone who uses 10Base-T Ethernet. You simply install a new NIC (network interface card) and replace or upgrade a hub. No rewiring is necessary, and the resulting network can still handle traditional packetized data.

Supporters say isochronous Ethernet is a viable technology in itself, or it can economically serve video applications while the market sorts out standardization issues for more expensive technologies, such as ATM. "It may be a transition technology, but that transition period could last five years or more," says Ken Carpenter, a project manager and software engineer with IBM's Networking Software Division (Atlanta, GA), which plans to sell videoconferencing software that supports isochronous Ethernet.

But other vendors are skeptical. "We've been looking for the holy grail for sending digital video and voice over networks, and we believe that's ATM," says Bill Brown, business unit manager for connectivity products at Apple (Cupertino, CA).

Paul Callahan, director of networking strategy for Forrester Research (Cambridge, MA), adds that the lack of support so far by major hub vendors like Cabletron and SynOptics will also impede market acceptance. Until video networks are standardized, LAN managers will move cautiously to satisfy demands for higher bandwidths and video traffic, Callahan believes. "That means switched Ethernet with ATM on the backbone," he says.

The first signs of whether isochronous

Ethernet will bring multimedia to the desktop or ever get off the ground will appear sometime in the second quarter of this year, when the first commercial products come to market. In the meantime, the technology illustrates why video over networks is demanding and what technological decisions companies have to make if they want such applications as videoconferencing, distance training, or interactive presentations throughout their enterprise.

High Bandwidth

In the minds of many people, digital video and LANs are the oil and water of computer networking: Conventional wisdom holds that the two don't mix. There are bandwidth constraints. Movie-quality video requires a data transfer rate of up to 6 Mbps. Similarly, a QuickTime video session of 1 Mbps from a file server can claim as much as 10 percent of Ethernet's bandwidth.

Beyond bandwidth, multimedia demands isochronous transmissions, meaning that data must move at fixed intervals with little or no delay. But conventional LANs fall short in being able to deliver continuous data streams because they use half-duplex protocols, which are designed for the bursty traffic patterns intended for transmitting text and numerical data.

For traditional data, the worst consequence of a LAN's start-and-stop nature may be a file transfer that pauses for a few seconds. But for digital video applications, pauses and disruptions in the data flow are annoying at best and, at worst, the causes of unintelligible information.

Finally, packet collisions and retransmissions are a way of life for many LANs. With Ethernet's bus topology, each device looks for a clear space to transmit. If traffic becomes heavy, multiple devices may try to transmit at the same time, and packet collisions may result. If a collision occurs, all devices must retransmit their data. This leads to even more collisions. This is why most network managers consider 40 percent of total bandwidth to be the maximum available bandwidth over an Ethernet network. Heavy multimedia traffic can render an overloaded Ethernet network nearly useless. Token Ring or FDDI (Fiber Distributed Data Interface) are less susceptible to breaking down, although these two ring topologies can run out of bandwidth if traffic gets heavy enough.

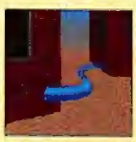
Networking Alternatives

Isochronous Ethernet is not the only method of handling isochronous data over networks. Here's the current field.

WAN Links

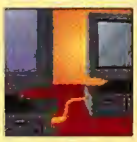
When it comes to digital services, ISDN is popular for multimedia applications, because it was designed from the ground up to support isochronous applications. With modem compression algorithms and multiple B channels, ISDN can efficiently support audio and video. However, it requires service orders, telephone company installation, and widespread availability of ISDN services to be fully useful.

T1 circuits are leased lines for point-to-point communications. These dedicated circuits are limited because only predetermined people can be included in the multimedia sessions. Like ISDN, it takes service orders to the telephone carriers to execute changes to add or delete sites, and customers may sometimes have to wait weeks for changes to be made.



Workgroup Lineup

Pace from 3Com sends a mix multimedia and traditional data traffic over Ethernet and awards the highest priority to isochronous traffic. Regular data traffic is slowed because of its lower priority, but time-sensitive information has a better shot at getting through. However, this leads to potential problems with data collisions, particularly if several isochronous applications are attempting to run simultaneously over the same Ethernet segment.



Western Digital's ISOnet provides a single, stand-alone isochronous mode that handles isochronous traffic similarly to isochronous Ethernet. There is, however, no provision for a data channel running on the same Ethernet with ISOnet.

Like isochronous Ethernet, SDV (switched digital video) from AT&T uses ISDN's Q.931 signaling protocol and a connection-oriented service. Unlike isochronous Ethernet, SDV runs strictly at the application level and requires an infrastructure, such as ISDN, for the equivalent of isochronous Ethernet's C channel. SDV is only a higher level (4 and up) protocol.

Proposed by Hewlett-Packard and AT&T, 100VG-AnyLAN supports Ethernet packets at 100 Mbps rather than the traditional Ethernet bandwidth of 10 Mbps. A protocol called Quartet Signaling uses four cable pairs to transmit data giving 100VG-AnyLAN the same 100-Mbps bandwidth as FDDI (Fiber Distributed Data Interface) or other fast Ethernet solutions. What 100VG-AnyLAN doesn't offer is a stand-alone circuit-switched channel for multimedia services. The channels compete for the same 100-Mbps bandwidth as does data traffic. However, some compromises have been made to favor isochronous applications.

100VG-AnyLAN's Demand Priority arbitrates packet transmission requests. This tends to avoid packet collisions by allowing multimedia traffic to get through in a more timely fashion. In addition, a hub can arbitrate requests by acknowledging higher-priority multimedia packets before lower-priority requests.

The Usual Suspects

Digital services:
- ISDN and T1

LAN services:
- Pace, Isonet, SDV, 100VG-AnyLAN, FDDI, and ATM

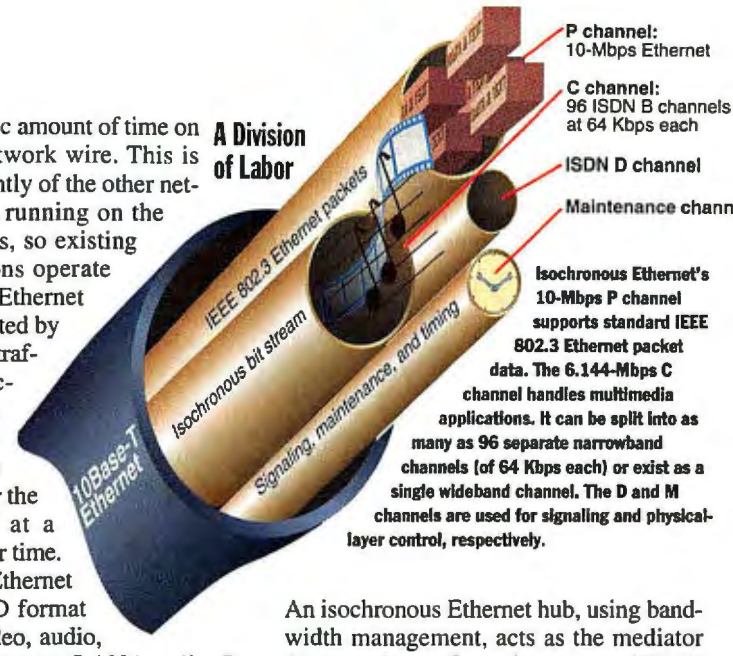
Migration to 100VG-AnyLAN is much like a move to isochronous Ethernet. It is possible to connect 100VG-AnyLAN devices to existing Ethernet networks and upgrade in stages. Corporations can upgrade individual stations or hubs on an as-needed basis.

FDDI is designed for data transport

Cost Benefits

Even skeptics acknowledge that isochronous Ethernet can overcome these problems (for an overview of competing technologies, including ATM, see the text box "Networking Alternatives"). Isochronous Ethernet glues together channels that handle isochronous and packet data separately and transports the two data types over existing Ethernet 10Base-T LANs that use Category 3 UTP (unshielded twisted pair) or higher. Thus 10Base-T-network administrators avoid rewiring costs.

Isochronous Ethernet is closely related to ISDN in that they use multichannel protocols and are based on TDM (time division multiplexing), a technique for multiplexing multiple channels over a single physical medium. TDM allocates to each channel a specific amount of time on the physical network wire. This is done independently of the other network protocols running on the same cable pairs, so existing LAN applications operate on isochronous Ethernet facilities unaffected by the isochronous traffic. By time slicing, isochronous Ethernet transmits isochronous information over the Ethernet LAN at a constant rate over time.



Isochronous Ethernet's 10-Mbps P channel supports standard IEEE 802.3 Ethernet packet data. The 6.144-Mbps C channel handles multimedia applications. It can be split into as many as 96 separate narrowband channels (of 64 Kbps each) or exist as a single wideband channel. The D and M channels are used for signaling and physical-layer control, respectively.

Isochronous Ethernet uses a P+96B+D format that can mix video, audio, and Ethernet into one LAN bundle. By comparison, in North America, BRI (Basic Rate Interface) ISDN is 2B+D (two bearer and one delta channel), and 23B+D for PRI (Primary Rate Interface). As the figure "A Division of Labor" illustrates, isochronous Ethernet's 10-Mbps P (packet data) channel supports standard IEEE 802.3 Ethernet packet data. A 64-Kbps D channel is used for signaling, much as it is for ISDN service. The M (maintenance) channel is a 96-Kbps channel that provides physical-layer status and control information. The 6.144-Mbps C (circuit mode) channel handles multimedia applications. Isochronous Ethernet allows you to split the C channel into as many as 96 ISDN B narrowband channels (of 64 Kbps each) as desired, or it can combine the channels to add 64-Kbps bandwidth or make a single 6.144-Mbps wideband channel.

Unlike traditional 10Base-T Ethernet, which uses the Manchester encoding scheme to send data over the physical connection, the isochronous Ethernet standard specifies 4B:5B encoding. The latter is also used in FDDI networks and benefits isochronous Ethernet by supporting the 10-Mbps packet channels and 6.144-Mbps isochronous bandwidth, as well as 10 Mbps of Ethernet over 100 meters of UTP cabling.

Isochronous Ethernet's bandwidth-on-demand lets you request whatever video quality you need for each connection. Thus, participants in a video conference, for example, can reserve a large portion of bandwidth for continuous and immediate full-motion video. By contrast, someone who wants to send a short video clip without audio needs to select only a small segment of the isochronous-Ethernet pipe. An isochronous Ethernet hub, using bandwidth management, acts as the mediator that awards or refuses the requested WAN bandwidth based on availability, or it can tell you what lower-bandwidth service is available. Isochronous Ethernet uses a separate 6.144-Mbps channel between each user and the hub.

Seamless Networking

The figure "Multimedia Network" shows a prototypical isochronous Ethernet-hub configuration. According to specification 802.9a, isochronous Ethernet hubs will support standard 10Base-T Ethernet, so only those workstations that require isochronous capabilities have to be upgraded with isochronous Ethernet NICs; workstations that need only access to text and numerical data can plug into the hubs using traditional NICs.

The figure also shows that the PSTN (Public Switched Telephone Network) can be connected directly to the hub (both the intelligent telephone and the remote video workstation shown in the figure connect to the hub through an ISDN connection). This allows remote users to participate in multimedia applications on the LAN. The hubs support switched digital services, such as ISDN (BRI or PRI) and T1. This also means that for the first time 10Base-T hubs will have mixed RJ-45 connectors: Some will be used for 10Base-T, and some will be used for ISDN. Because ISDN and the 10Base-T RJ-45 specification use different pins for each service, users should be relatively safe if they accidentally plug the wrong service into the wrong jack.

While important, WAN connectivity has its limitations. Don't assume that an ISDN connection to an isochronous Ethernet hub offers remote LAN access. This is not the case unless the hub supports

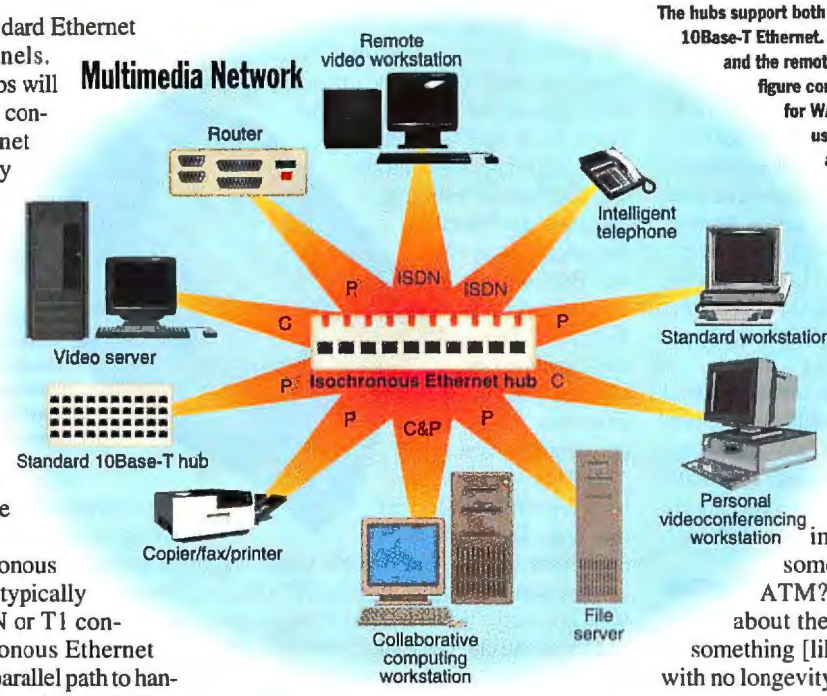
and, like Ethernet, doesn't efficiently handle isochronous traffic. FDDI is half-duplex. The only major advantage to running multimedia applications over FDDI is enhanced bandwidth (100 Mbps).

ATM, the standard for 25- or 155-Mbps and faster LANs, is perhaps isochronous Ethernet's biggest nemesis. ATM provides the same services that isochronous Ethernet does but at significantly higher bandwidths. ATM promises to bring voice, video, and data together into one big interoperable high-speed mix.

Once fully deployed, ATM will support wide-area access to data, audio, voice, and video. However, the slow rate of ATM deployment plays into the hands of isochronous Ethernet's proponents. ATM equipment is expensive, and it's not always interoperable. Today's ATM connections are largely limited to local installations. Unlike isochronous Ethernet, ATM has no widely spread infrastructure.

Both ATM and isochronous Ethernet are ISDN-based protocols. ATM is based on broadband ISDN, and isochronous Ethernet is based on narrowband ISDN Basic Rate Interface and Primary Rate Interface service. In the end, vendors may be squaring off to fight the battle of the ISDNs.

delivery of both the standard Ethernet and isochronous channels. Isochronous Ethernet hubs will support P and C channel connections to their Ethernet ports. However, only some of those hubs will support P and C channel connections to remote users over the ISDN ports. Other, presumably less expensive, hubs will support only the C channel for remote connections. It is also a function of the remote device's ability to handle the P and C channels.



The hubs support both isochronous and standard 10Base-T Ethernet. Both the intelligent telephone and the remote video workstation shown in the figure connect to the hub through ISDN for WAN connections. This lets remote users participate in multimedia applications on the LAN. P channels handle Ethernet packet data; C channels handle multimedia data.

For wide-area isochronous Ethernet, networks will typically need independent ISDN or T1 connections among isochronous Ethernet hubs. This establishes a parallel path to handle the C channel, and the traditional bridge or router deals with the P channel.

Through special software included in the isochronous Ethernet hub or through an MCU (multipoint control unit), three or more users can participate in the video sessions. Because isochronous Ethernet sets up private channels among individual users, it operates closer to switched digital circuits; thus, it's more likely to be kept private than standard LAN video or audio that is multicast over the network.

Red Flags

The most conspicuous group of vendors to support isochronous Ethernet includes National Semiconductor, IBM, Ericsson, and Zydacron. The group plans to bundle products for a turnkey conferencing application based on the H.320 videoconferencing standard.

The bundle will include National Semiconductor isochronous Ethernet NICs. IBM will supply conferencing software based on its Lakes Collaborative Networking Architecture, midddleware that will support isochronous Ethernet in a new release slated to ship in the second quarter of this year. Ericsson will offer isochronous Ethernet hubs, and Zydacron will contribute H.320 codecs for compressing and decompressing digital video and voice signals. Incite, a division of Intecom, has also announced plans to sell isochronous Ethernet hubs.

Where to Find

National Semiconductor Corp.
Santa Clara, CA
(800) 272-9959
(817) 468-6300
fax: (817) 468-6938

According to Bob Rittle, manager of conferencing products for IBM's Networking Software Division, the group planned to demonstrate the product at CeBIT, in Hannover, Germany, last March, with commercial shipments to begin in the second quarter of this year. "Isochronous Ethernet may not take over the world," Rittle says, "but it will establish a market niche."

However, Apple's Brown sees "little mind share" among network administrators for isochronous Ethernet. "People who want to change their networking environment are opting for ATM," according to Brown. "25-Mbps ATM is tied into our development efforts for the PCI-based machines that are due out this summer."

Cost is another concern. Traditional Ethernet NICs sell for under $100, and hub prices have dropped to below $1000. Although pricing is still not set, National Semiconductor believes that isochronous Ethernet hubs and cards will be available for less than today's typical workgroup switched Ethernet solutions, which range from $500 to $1500 per user, including the NIC and hub port. But this is high compared to the roughly $150-per-seat cost of current Ethernet adapter cards and hubs. Brown says that 25-Mbps ATM costs companies about $900 per seat, and in six months, prices could drop to $600 per seat.

He adds that while isochronous Ethernet costs may not include rewiring, some companies will balk at the cost of upgrading NICs and hubs. "If you're going to make that investment, why not go to something with legs, such as ATM?" he reasons. "I wonder about the wisdom of investing in something [like isochronous Ethernet] with no longevity."

The Checkered Flag

For isochronous Ethernet to become widely accepted, the demand for video and audio services over LANs needs to take off. Isochronous Ethernet can provide a transition as long as ATM is restricted to being the WAN connection to the isochronous Ethernet hub and not a link from the hub to desktops. The latter incurs another round of costs to replace isochronous Ethernet hubs and NICs with those that support ATM.

In the end, time is not on isochronous Ethernet's side. ATM deployment may be slow, but it is happening. To compete, isochronous Ethernet devices must quickly become standardized, readily available, and cost-effective. Isochronous Ethernet has a chance at success, but the window is small. Multimedia over the network is coming your way. The question is, how will it get to your desktop? ■

ACKNOWLEDGMENT

Dr. Dhadesugoor Vaman of Stevens Institute of Technology, Michael Pihlman of Innovative Telecommunications Solutions, Stephan Ohr of Indian Forest Research, and Dory Leifer assisted in this article.

Jeffrey Fritz is a telecommunications engineer responsible for data communications and the ISDN lab at West Virginia University. He is also the author of Sensible ISDN Data Networks *(WVU Press, 1992). You can contact him on the Internet at jfritz@wvnvm.wvnet.edu or on BIX c/o "editors."*

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intel inside

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Notebook Comparison Chart

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Microprocessor Capacity	486X-33 to DX4-100	486SX-33 to DX4-100	Pentium 90MHz 75 MHz
Screen Size	9.5"TFT 10.3"DSTN	10.4" TFT/DSTN	10.4"TFT and DSTN
Max. RAM Capacity	20 MB	36 MB	40 MB
Infrared Link	No	Yes	Yes
BUS Slots	Local	Local	PCI
Sound Chip	SoundBlaster	SoundBlaster Pro	SoundBlaster Pro
Speakers	1 built-in	2 built-in	2 built-in
Pointing Device	Trackball	TrackPoint	Trackball
Remov. Modular	N/A	Yes	N/A

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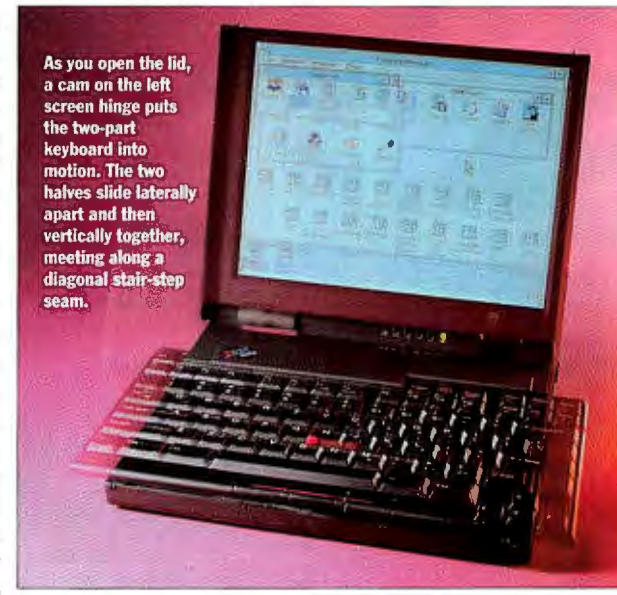
Incredible Expanding Keyboard

IBM's new ThinkPad 701C shatters subnotebook constraints with a full-size keyboard and screen

ALAN JOCH

A house divided may fall, but a home row divided may finally make the subnotebook a viable form factor. That's the idea behind the split keyboard that IBM introduced on the new ThinkPad 701C, a cleverly designed, 4.5-pound portable.

Once opened, the keyboard on the 701C (nicknamed *the Butterfly*) extends past the chassis sides to give you the largest and most comfortable keyboard in its class. But when you turn on the unit, what really pops out is the impressive 10.4-inch display. Our review unit sported a TFT (thin-film transistor) screen, but the 701 is also available with a dual-scan display. Add IBM's TrackPoint III pointer, and the result is today's most ergonomically correct subnotebook.



As you open the lid, a cam on the left screen hinge puts the two-part keyboard into motion. The two halves slide laterally apart and then vertically together, meeting along a diagonal stair-step seam.

Crowded House

An Intel 486DX2/50 processor powered our review unit and ran applications in acceptable but not house-burning speed. (Battery life was an impressive 6 hours.) A 486DX4/75 version will also be available. The DX2 comes standard with 4 MB of memory (20 MB maximum) and a 360-, 540-, or 720-MB hard drive. The DX4 will come standard with 8 MB of memory.

The 701C joins a handful of new subnotebooks that run high-end 486s and offer larger color displays and roomier keyboards. The closest competitor to the 701C may be Gateway's Liberty, which also offers a 10.4-inch display (dual-scan color). A comparable 486DX2/50 Liberty costs about $950 less than the 701C.

However, the Liberty doesn't give you the satisfying *cha-chunk* that you get on opening the 701C, as its 11.5- by 5.75-inch keyboard slides into place. A clever mechanism splits the 85-key keyboard in half with a diagonal cut from upper left to lower right. When you snap down the lid, the right segment inches up and then both segments slide in. The closed 701C measures just 9.7 by 7.9 by 1.7 inches. The solid keyboard mechanism never failed to perform. We opened and closed the 701C countless times during our evaluation but can't verify IBM's claim of achieving 25,000 fail-free repetitions.

What does the split keyboard buy you? All the primary keys are the same size as those of a desktop keyboard. The function and arrow keys are about half as big but much more generous than the Pez-size buttons on previous ThinkPad subnotebooks like the 510C. Our only complaints: There is no wrist rest, which is troubling because Apple and others have already considered wrist stress in their designs; and the heel of the right hand comes down on the arrow keys when you are typing.

What a View

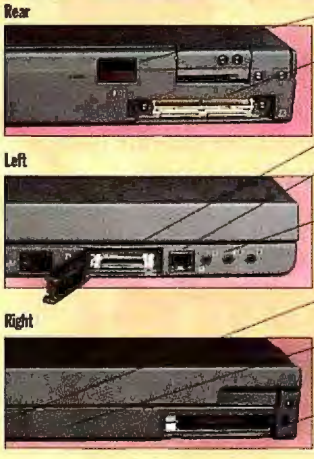
The 701C's remarkable 10.4-inch screen compares with full-size ThinkPads and displays 26 lines of text in eye-pleasing 12-point type. By comparison, the 510C displays the same amount of copy in 10-point type. IBM says the display shortages that have delayed orders for some ThinkPads aren't a factor for the 701C, thanks in part to outsourcing from Sharp.

The 701C comes with audio and telephony features similar to those of the larger and faster 755C, but because of its sliding keyboard, the 701C doesn't have space for a CD-ROM drive. The 701C's modem isn't upgradable from 14.4 Kbps. With a 256-color palette, the 701C doesn't have the 755C's more sophisticated graphics system (65,536 colors at VGA resolutions). Finally, the 701C can't capture or output broadcast-standard video.

The 701C does, however, shine among portables for pleasantness to use and for flat-out coolness. *Cha-chunk* may soon become the sound of status for those who live much of their life at 35,000 feet. ■

Alan Joch is a BYTE senior editor. You can reach him on the Internet or BIX at ajoch@bix.com.

ThinkPad 701C Features



Infrared port transfers files at 115 Kbps.

Expansion connector attaches the included port replicator.

Parallel port for external 0.57-pound floppy drive.

14.4-Kbps data/fax modem.

Yamaha Codec provides 16-bit stereo audio. Built-in microphone and speakers.

Nickel-cadmium battery doesn't require full discharge before recharge.

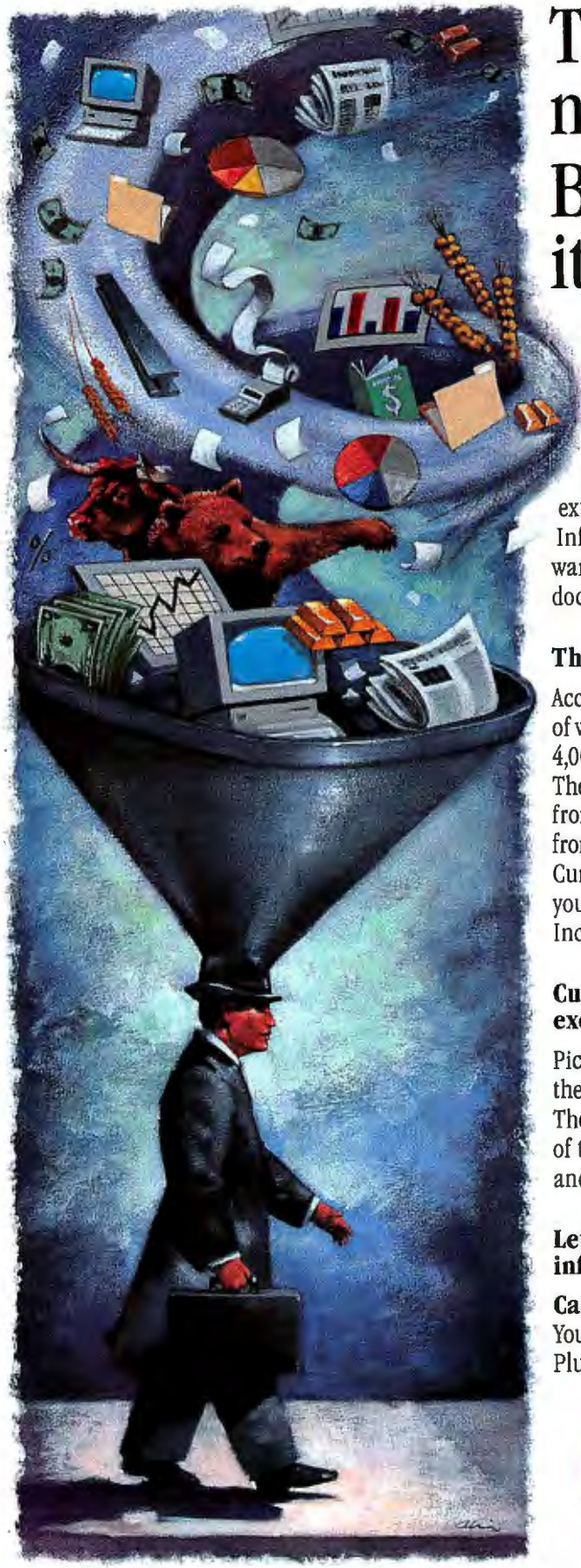
Hard drive (360, 540, or 720 MB) removes for security or for segmenting work.

PCMCIA slot for two Type II cards or one Type III card.

Product Information

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The Benefits of Recentralization

Microsoft's Systems Management Server helps bring the anarchy of multiple-vendor networks under centralized control

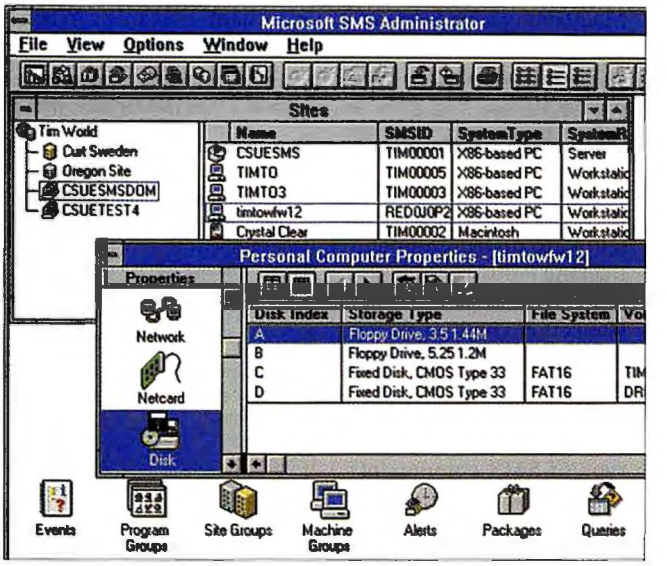
ETHAN WILANSKY

Intelligently managing networked computers has become difficult and complex. One complicating factor is the plethora of management tools that use different OSes and front ends. Each management application is configured separately and often uses proprietary data collection, remote control, and software distribution.

Microsoft seeks to resolve these problems with SMS (Systems Management Server), a suite of network management utilities. Using Microsoft's Windows NT Server and Windows NT SQL Server as its underlying OS and database, respectively, SMS provides four major management functions: hardware and software inventorying; electronic software distribution; shared application management; and remote-control and network monitoring.

SMS is an integrated set of node-level tools that use industry-standard methods for managing the network. It distinguishes itself from the competition by using the NT SQL Server database as its foundation. This means, for example, that when a network manager defines a software update procedure that executes only on a client if CPU or disk space is adequate, the client's characteristics are determined by querying the NT SQL Server database.

SMS provides an open environment to support three of the most popular NOSes (network operating systems), Novell NetWare 3.1x and 4.x (in bindery emulation mode only), IBM's LAN Server 3.0 and 3.1, and Microsoft LAN Manager 2.1 and higher. This open systems philosophy extends to data collection and reporting via ODBC (Open Database Connectivity), DMI, and SNMP. Client OSes—such as Mac System 7, OS/2 2.x, MS-DOS 5.x or higher, and the Microsoft Windows family—are supported for varying degrees of systems management (for details, see the table "SMS-Supported Operating Systems"). NT's support of such popular industry protocols as TCP/IP, IPX, SNA (Systems Network Architecture), RAS (Remote Access Service), and NetBEUI lets SMS use any of these protocols for data gathering, management, and distribution.



Systems Management Server stores network inventory data in an NT SQL Server database. Here, a database report highlights the disk configuration of a node on the network.

To operate SMS, you need NT Server ($699) and NT SQL Server ($999). The CPU, disk, and RAM requirements depend on the number of workstations and on how dispersed—from a single segment LAN to many routed WANs—the network is.

For our tests, we ran SMS on five NetWare log-on servers. Two of these were located at our Bethesda, Maryland, test site, and the other three were accessed remotely across a frame-relay link. Of the three remote servers, two were connected via 256-KB lines, and one was on a 56-KB line. Clients were dispersed throughout the local and remote sites and ran a variety of OSes, including Windows 3.1, MS-DOS 5.0 or higher, WFW (Windows for Workgroups) 3.11, Mac System 7, and OS/2 2.1. Last, but not least, we ran SMS on two NT servers, one of which functioned as the central site server.

Building on a Strong Foundation

SMS uses a format called MIF (management information file), developed by the DMTF (Desktop Management Task Force), for collecting inventory information about the hardware on the network. It also uses SNMP services for monitoring SMS servers from a network management station, such as Hewlett-Packard's OpenView. In addition, IBM's NetView network management software can receive SMS status information if an NT server is running Microsoft SNA Server.

Inventory Management

Inventory data collection underlies all SMS's key operations. At the central or primary site servers, you decide the schedule and frequency of inventory collection for managed sites. Constant updates to the SMS database keep the inventory current, regardless of whether clients have been added or reconfigured. The inventory can encompass such items as hardware disk type, names of workstation boot files, installed software, and BIOS revision dates.

SMS provides a sophisticated query function that lets you use stored inventory information to complete a selective software upgrade through SMS, to document the network, or to trigger an alert condition in the event log. You can also save defined queries for future use.

We found the inventory function to be the most robust and well-designed SMS component. However, the data we collected was sometimes incomplete. For example, our database contained no mention of the SCSI controller on a Tricord ES5000 server running NetWare 3.12. The reason is that SMS uses standard NetWare APIs to collect information from NetWare servers, and those APIs report only NetWare volume (not disk controller) information, the OS version, and other server information tracked by the NOS.

In addition, on some stations at the Bethesda, Atlanta, and San Francisco test sites, the SMS boot-configuration component didn't run because other batch

procedures executed commands that dumped users out of their boot files before the SMS agent TSRs could run. After we reconfigured the batch routines, the agents ran fine.

Electronic Software Distribution and Management

Maintaining a hardware inventory is hard enough; add ESD (electronic software distribution) and software management, and you have a nightmare. To help with this management headache, SMS provides a robust and highly configurable set of software distribution and tracking tools.

From a central or primary site server (both of which can function as a multisite hub, although only the former sits atop the hierarchy), you can create a *package* (a type of SMS component) that defines how an application you want to distribute will be installed, executed, or tracked for inventory.

For configuring packages, SMS uses PDFs (package definition files), which consist of scripts for setting up Microsoft OSes, (e.g., MS-DOS, Windows, and NT) and Microsoft applications, such as Excel 5 and Word 6. Also included is a run-time version of Microsoft Test for running precompiled scripts. (Compiling your own scripts requires the retail version of Microsoft Test, which is not included with SMS.)

Each package provides the information necessary for running a task. Its own delivery, however, is handled through a *job*, which is analogous to addressing and carrying a letter to a mailbox for delivery.

Overall, the package component is slick, but its run-time version of Microsoft Test for script compiling leaves something to be desired. We found using a third-party scripting language like WinApps Installer was the quickest and easiest alternative.

For software installation to execute, the client must have available a PCM (package command manager). Microsoft provides PCMs for computers running MS-DOS 5.0 or higher, Windows 3.x, WFW, NT, and Mac System 7. Currently, there are no PCMs for OS/2 or Unix systems. However, you can run the Windows PCM from an OS/2 Windows shell. At this writing, Digital Equipment was shipping beta versions of a Unix client for SMS. Also, because Mac System 7 doesn't support running applications from the network, you can't share server-based applications.

Shared application management, a main function of SMS, can be used to distribute software to any server in the SMS environment. When setting up shared applications on a server, it's important to make the applications easily accessible to users. For Windows 3.x and NT clients, you can use SMS's PGC (Program Group Control) utility to make application icons appear on each client workstation.

Unfortunately, DOS, Windows 3.x, and NT are the only platforms that can take full advantage of PGC's automation features. If you use a third-party Windows shell or OS/2, you must also use a third-party icon management utility to centrally manage each desktop.

Remote-Access Utilities and Network Monitoring

For real-time user support, SMS offers three functions: a diagnostic utility for viewing client configurations, network monitoring for collecting raw data frames or packets while troubleshooting network problems, and remote control (also called help desk). The diagnostic utility lets you, for example, view the device drivers loaded on a DOS workstation. On a Windows station, it lets you see the local heap space used for the GDI (Graphical Device Interface). Network monitoring lets you set network alert triggers for executing any program or task. For remote-control and diagnostic support, SMS can access clients running DOS, Windows, and WFW. Surprisingly, SMS does not support NT or Macintosh clients for diagnostic or help desk functions.

The host and viewing station must have the same protocols bound to the NIC (network interface card) for these remote facilities to function. The administrator monitors the DOS, Windows, or WFW client via a LAN or RAS connection.

Network monitoring also requires either a promiscuous-mode NIC at the monitoring site (i.e., a NIC that receives all frames on the network) or a connection to a remote network monitoring agent running a promiscuous-mode NIC. A wide variety of LAN and WAN protocols running RAS are supported for SMS network monitoring.

SMS remote control doesn't work with OS/2, NT, and Mac clients, although NT support is expected by year's end, and Microsoft is considering adding native OS/2 and Mac support.

SMS-SUPPORTED OPERATING SYSTEMS

	MS-DOS 5.X OR HIGHER	WINDOWS 3.1	WINDOWS FOR WORKGROUPS	WINDOWS NT	MAC SYSTEM 7	OS/2 2.X
Client services						
Inventory management	●	●	●	●	●	●
Remote control	●	●	●	○	○	○
Network monitoring[1]	●	●	●	●	●	●
Client diagnostic utility	●	●	●	●	○	○
Shared applications	●	●	●	●	○	●[2]
Software distribution	●	●	●	●	●	●
Server types[3]						
Central site	○	○	○	●[4]	○	○
Primary site	○	○	○	●[4]	○	○
Distribution	○	○	○	●	○	○
Log-on	○	○	○	●	○	○
Helper	○	○	○	●	○	○

Note: Table information doesn't include NOSes; ● = yes; ○ = no.
[1] Limited monitoring is possible on any client with a supported protocol, but only Windows NT and Windows for Workgroups support full, agent-based monitoring.
[2] Although you can run shared applications from a server, SMS cannot handle client configuration and icon setup on the Presentation Manager desktop.
[3] Distribution and log-on servers can also run Novell NetWare 3.x and 4.x, Microsoft LAN Manager, and IBM's LAN Server.
[4] Only Windows NT Server can act as a central or primary site server.

A Complex Route to Simplification

SMS is not for administrators who want a simple solution to network management. It's a complex product that demands careful planning before you can implement it.

That said, Microsoft has created a powerful suite of network management tools. When taken individually, SMS's management components are above average. Its distribution mechanisms and client support are superior to those of any product on the market, but they aren't what distinguishes SMS from its competitors. SMS really shines as a total network management platform. Its multiprotocol and multi-NOS support are unmatched. ■

Product Information

Systems Management Server. . . . . $649 per server
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Microsoft Corp.
Redmond, WA
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(206) 882-8080
fax: (206) 936-7329
Circle 976 on Inquiry Card.

Ethan Wilansky is a Maryland-based network integration consultant and instructor for Microsoft and NetWare networking products. He can be reached on the Internet at ewilan@clark.net or on BIX c/o "editors."

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Small-Scale Telephony

Six multifunction telephony boards manage fax, voice, modem, and sound

TOM YAGER

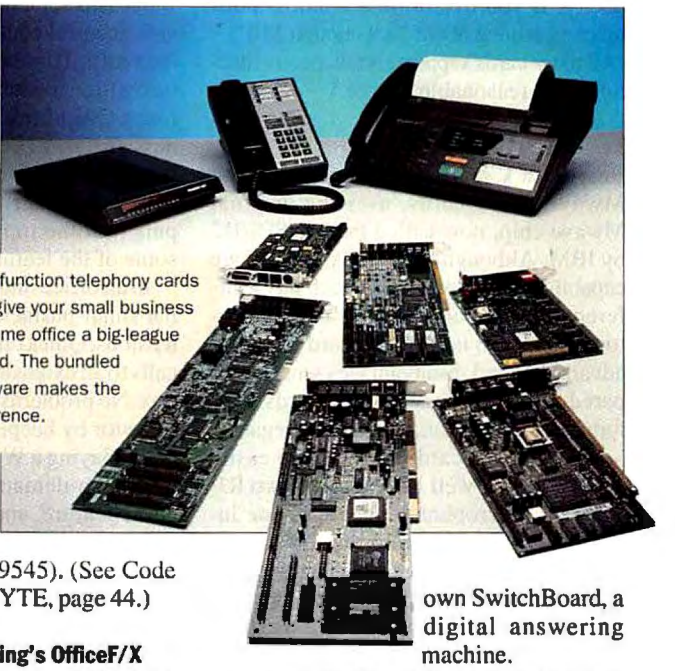
Affordable computer telephony products are a boon to small businesses and work-at-home professionals. The low prices come from increasingly inexpensive DSPs (digital signal processors). These chips can single-handedly juggle voice messages, faxes, data communications, digital audio, and more. Equipped with one of these programmable chips, an expansion card can act as a combined data/fax modem, multimedia sound card, and telephony board for under $400. Besides giving your enterprise a big-business feel, these multifunction cards conserve scarce expansion slots and reduce configuration hassles.

DSP programmability also provides an easy route to correct bugs and enhance functions (upgrade modem speed—to a limit—or add caller ID capability). Five of the six cards reviewed use programmable DSPs. As you'll see, however, effective telephony doesn't require a DSP, nor does a DSP ensure effective telephony. In all cases, the software makes the difference.

The cards in this review are based on the ISA bus and support 14.4-Kbps (V.32bis) or faster modem traffic, 14.4-Kbps fax transfers, and digital audio at sampling rates of 44.1 kHz in 16-bit stereo. All six cards can record and play audio through the phone line, an external speaker and microphone, or a locally connected telephone handset. Windows audio software is standard, and each card has at least one CD-ROM controller. A joystick/MIDI port is common but not universal.

Three of the cards use a version of IBM's Mwave chip and DSP OS; two use AT&T's 32xx Roadrunner DSP with its VCOS (visual caching OS). Also tested was a non-DSP card from Boca Research that manages to squeeze enough circuitry onto a full-size card to provide voice, fax, modem, and sound functions. We didn't look at WindSurfer, IBM's own Mwave card, because a new version replaced it after this review was completed. Non-DSP cards from Creative Labs and Diamond Multimedia weren't ready to review.

The test platform was a 66-MHz Boss 486DX2 with 28 MB of RAM and a network card. All products come with Windows-based telephony applications. Keep in mind that if you don't find the telephony functions you want with these cards, you can get them with a little programming. All the reviewed Mwave cards, for example, work with Visual Voice for Mwave (Stylus Innovation, Cambridge, MA, (617) 621-9545). (See Code Talk, November 1994 BYTE, page 44.)



Multifunction telephony cards can give your small business or home office a big-league sound. The bundled software makes the difference.

Spectrum Signal Processing's OfficeF/X

Like other Mwave cards, the OfficeF/X is a small half-length card with many Mwave-based software features. It supports V.17 (14.4 Kbps) faxing, V.32bis data transmission (with claimed upgradability to V.34), 16-bit stereo sound sampling at up to 44.1 kHz, wave-table sound synthesis, MIDI capability, Sound Blaster compatibility, and telephony features.

OfficeF/X is the first card to use the latest Mwave DSP, the MDSP2780, which brings more processing power and on-chip Sound Blaster hardware compatibility. The card has connections for audio line inputs and outputs (through stereo ¼-inch phone jacks), a microphone input, and a joystick/MIDI port. The line output drives headphones directly (an Mwave mixer applet is included). One telephone jack connects both phone line and handset with the RJ-12 pigtail splitter that Spectrum supplies.

With no DIP switches or jumpers, setup should have been simple using the card's graphical DOS installation program. In most cases, you just select "automatic setup and test" and wait a few seconds. We weren't so lucky. OfficeF/X's installation refused to accept the COM2 setting, even though it was unused by other hardware. It finally worked with COM3.

OfficeF/X comes with Delrina's WinFax Lite and WinComm Lite, MKS Internet Anywhere for E-mail, and Spectrum's own SwitchBoard, a digital answering machine.

SwitchBoard's unified inbox lists fax, voice, and E-mail messages. SwitchBoard handles voice messages itself and communicates with WinFax Lite and Internet Anywhere to meld their receive logs into one. OfficeF/X's Mwave software manages audio, fax/modem, and wave-table synthesis pretty well, though we did find the digital audio quality somewhat wanting. When we listened to messages and calls through headphones, the card emitted a constant pink noise/whine that made listening unpleasant. Muting the inputs in the mixer applet didn't help.

The Mwave discriminator routine determines where each incoming call should go: voice, fax, or data. You can also set up brute-force discrimination, letting the caller indicate the call type with DTMF Touch-Tones, or depend on caller ID and phone-number information you enter into OfficeF/X's contact list.

WinFax Lite and WinComm Lite are arbitrarily crippled. SwitchBoard supports multiple incoming mailboxes, but beyond that, its features are only equal to a $99 answering machine. It has no message forwarding or beeper notification, no voice-menu programmability, and no fax forwarding or fax-on-demand. In short, OfficeF/X is just about what you'd get if you combined an average fax machine, modem, and answering machine.

When running Windows, Mwave acts

PHOTOGRAPHY: ED JUDICE © 1995

as an acceptable wave-table synthesizer. It can handle simultaneous fax and MIDI, audio and modem, or almost any combination that doesn't overtax the DSP's capacity. If you overdo it, a window pops up complaining about "not enough MIPS." (All these cards support simultaneous functions to a reasonable degree.)

Best Data's ACE 5000

Best Data's ACE 5000, one of the first Mwave-based cards, uses the original Mwave chip, now called the MDSP1012 by IBM. Although the Mwave cards share capabilities and are similar, each has a different layout, components, and connectors. The ACE half-length card has clear advantages and disadvantages when compared with the other Mwave cards. Unfortunately, the balance tips to the negative.

On the ACE card, all ports are easily accessible and well labeled, with two RJ-11 jacks, microphone input, and line input and output. This card supports only a single CD-ROM drive type—Panasonic. A MIDI connector kit is optional. Installation isn't nearly as straightforward as with OfficeF/X, because the ACE card has both jumpers and DIP switches. Worse, Best Data's hardware sniffer utility works well only if you get the settings right the first time. After using it once, if you try different port and IRQ (interrupt request) combinations, you must first pull the board and manually remove all references to the previous ACE installation from your SYSTEM.INI file.

The ACE card comes with QuickLink Message Center, from Smith Micro Software. This somewhat uneven program provides central control with a unified inbox (actually, 10 inboxes organized as mailboxes) for incoming voice messages and faxes. QuickLink's impressive list of business features (i.e., operator paging, call transfer, fax-on-demand, remote fax retrieval, and pager notification) seemingly puts it at the top of the Mwave list, but some of the features are flawed.

In an office running on a Centrex or similar small-business phone system with extensions, QuickLink will transfer incoming calls to an extension identified by the mailbox. No problems here. It will also page an operator by beeping the system's speaker or by playing a WAV file.

Fax-on-demand should also be a welcome feature, and we were pleased with QuickLink's ability to automatically generate a faxable list of available documents. However, you can't view faxes as you add them to the list, nor is there callback capability. Callers must request fax-on-demand from the fax machine itself. And QuickLink doesn't offer callers any opportunity to verify document choices or delete selections.

Pager notification works, but it rings your pager even if the caller hangs up immediately. Configuration details are buried in deep trees of dialog boxes, which forces you to hunt for some common switches and parameters. The greetings and voice prompts supplied are useless demonstrations, requiring you to rerecord every message in your own voice. QuickLink also turned up the only application errors encountered during this review. While the errors weren't fatal—clicking the "ignore" button dismissed them—they did hang the application, and they were consistently repeatable after two reinstallations.

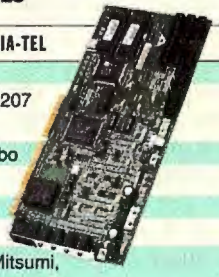
Taking advantage of DSP programmability, Best Data offers several upgrade options. You can upgrade the V.32bis data modem software to V.34, but it remains to be seen whether or not the MDSP1012 chip can handle 28.8-Kbps transmission with full four-times compression. Other software options are caller ID, full-duplex speakerphone, network fax, Q-Sound (simulated 3-D), and a three-way call discrimination (voice, fax, and data).

While QuickLink's list of business-oriented features stands out, the implementation simply doesn't measure up to our expectations for actual use. Overall, we rate the ACE 5000 behind OfficeF/X. The ACE card works with Visual Voice, if you have a custom application in mind. Or you can wait for the MDSP2780-based ACE 6000 with its upgraded software.

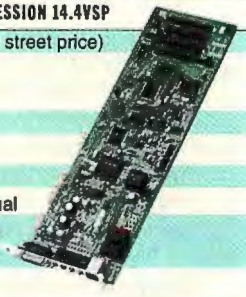
Objix Multimedia's Media Manager

Objix Multimedia's Media Manager is an Mwave card. Like the ACE 5000, this half-

MULTIFUNCTION TELEPHONY CARD FEATURES







	AMI MEDIA-TEL	BEST DATA ACE 5000	BOCA SOUNDEXPRESSION 14.4VSP
Price	$399	$299	$179 (estimated street price)
DSP	AT&T 3207	IBM Mwave 1012	Fixed function
14.4-Kbps fax and data modem	V.32terbo	●	●
Upgradable to V.34	○	●	○
Windows Sound System–compatible	●	○	●
Wave-table MIDI*	●	Optional	Hardware optional
CD-ROM connections	Sony, Mitsumi, Panasonic, IDE	Panasonic	Sony, Mitsumi, Panasonic, IDE
Microphone	○	○	○
Telephony Software Features			
Unified inbox	●	●	●
Multiple mailboxes	●	●	●
Caller ID	●	Option	●
Full-duplex speakerphone	●	Option	Half-duplex
Call auto-detect	Three-way	Two-way	Two-way
Message forwarding	Voice to other mailboxes only; forwards faxes	●	Message and fax
Pager notification	○	●	●
Remote message retrieval	●	Message and fax	Message and fax
Fax-on-demand	○	Limited	●

*All cards provide 16-bit 44MHz stereo sound with Sound Blaster capability. ● = yes ○ = no

length card uses IBM's MDSP1012 Mwave chip, and its features and DSP software capabilities are similar. A joystick/MIDI connector is standard (through an adjacent slot opening), and the audio connections (microphone, line in and out) run through a pigtail. There is a bundled microphone, and the card has a scanner port and software that supports scan to fax, giving you real fax-machine capability.

Automatic configuration by a Windows program makes installation straightforward. The card supports only one type of CD-ROM drive—Sony.

Media Manager comes with the most limited software of the six cards. The PhoneManager program handles voice calls, providing one mailbox, your choice of three greetings, and only the most basic telephone-plus-answering-machine functionality. Similarly, the Fax Desktop program offers little beyond the minimum required features of a fax machine.

The standard Mwave discriminator routes calls to PhoneManager and Fax Desktop, but there is no central manager to get voice and fax services running automatically. Fax Desktop also requires you to log in with a name and password, making it difficult to set your machine to restart itself after a power loss. The user interfaces are clunky, with separate voice and fax inboxes and poorly drawn icons.

The bundled microphone is a nice touch, but the card's line output wasn't strong enough to drive our headphones at an acceptable volume. In its present state, fax and voice support are so basic as to put the Media Manager in last place among its Mwave counterparts. The manual that came with the Media Manager card was stamped "preliminary," leaving hope that the software will move forward.



Multimedia Connect's main interface mimics a speakerphone. The Enter key lifts the receiver off the hook, and you can dial with your keypad. The mini inbox view shows newly arrived voice and fax messages. The program comes with the MediaMagic and AMI packages.

MediaMagic's Telemetry-32

This three-quarter-length multifunction DSP card was the first one to use AT&T's Roadrunner 3210 chip. The card's hardware features are impressive: four CD-ROM interfaces, stereo microphone input, audio jacks, dual RJ-11 telephone jacks, a game port, and a stereo microphone.

While the Telemetry-32's basic software capabilities are similar to the Mwave cards, that's where the similarity ends. For once, installation was truly automatic. The software includes Voyetra's Multimedia Sound Software for Windows, and voice and fax action are handled impressively by Syncro Development's Multimedia Connect with three-way call discrimination.

Multimedia Connect is hampered by a too-sparse manual, and the answering-machine software suffers from the common flaw of recording after an immediate hang-up. However, Multimedia Connect makes the Telemetry-32 telephony bundle professional and complete enough to put to business use immediately.

Surprisingly, Multimedia Connect's greetings and prompts are delivered by a clear, professional voice. The layout of the voice menus, mailbox access, and remote administration is clean and sensible. Multimedia Connect is clearly patterned after high-end voice-mail systems.

Its features go way beyond a unified inbox for fax and voice messages. The standard voice menus invite fax senders to attach voice messages, which then appear as icons in the fax viewer toolbar. You double-click on the icon to hear the message. Multimedia Connect also forwards faxes and messages to other mailboxes, and it will even forward faxes to another fax machine (with automatic retries and the ability to reprogram the forwarding number remotely). The program doesn't forward voice messages to other locations or notify pagers.

The stylish Multimedia Connect interface (see the screen) is compact enough to let you run other programs on a 1024- by 768-pixel screen. Also, the program can play WAV files to callers on hold. This big-system feature lets you annoy callers with marketing messages and music, but it keeps callers from wondering if they've been disconnected. The interface doesn't make it clear enough, however, that a caller is on hold.

Unfortunately, Multimedia Connect's Touch-Tone duration is too brief for most voice-mail systems to recognize, and the speakerphone introduces a jarring delay between your speech (into the microphone) and its playback in your headphones. Also, the board itself is a little noisy, playing a constant, almost tune-like, sequence of random tones through the headphones when the line is quiet.

The Multimedia Connect interface has a "terminal" button that enables the modem emulator and launches any external terminal program you choose. The package

MEDIAMAGIC TELEMETRY-32	OBJIX MEDIA MANAGER	SPECTRUM OFFICEF/X
$299	$379	$299
AT&T 3210	IBM Mwave 1012	IBM Mwave 2780
V.32terbo	●	●
○	●	●
●	○	●
●	●	●
Sony, Mitsumi, Panasonic, IDE	Sony	Panasonic, Sony
●	●	○
●	○	●
●	○	●
●	Option ($20)	●
●	Half-duplex	●
Three-way	Two-way	Three-way
Voice to other mailboxes only; forwards faxes	○	○
○	○	○
●	●	●
○	○	○

also includes AT&T's stand-alone data and fax modem emulators, so you can run third-party communications software.

The Telemetry-32 was up and running faster, and presenting a more professional interface to the caller, than the other cards tested. It has no pager notification or remote fax retrieval, but overall, we give the Telemetry-32 high marks and recommend it for any small business that wants to sound big.

American Megatrends' Media-TEL

American Megatrends (AMI) supplied its new Media-TEL card with prerelease installation software. With the same hardware and software features, this card is virtually indistinguishable from MediaMagic's Telemetry-32. (The cards aren't identical at the component level, though the Media-TEL uses two MediaMagic chips.) Both run AT&T Roadrunner chips at 55 MHz (AMI uses the 3207 version with no serial interface), both support four different flavors of CD-ROM drive, and both run Syncro Development's Multimedia Connect voice/fax manager. Only the Media-TEL provides a game/MIDI interface.

While the Telemetry-32's installation was smooth, the Media-TEL's wasn't. AMI told us its final installation routine will be good because it relies on the same hardware sniffing routines used in its AMIDIAG utility. The company includes an odd assortment of AT&T DSP demonstration programs, the most impressive of which made short work of JPEG image decoding. Reserving judgment on AMI's unfinished installation routine, we expect to like the Media-TEL as much as the Telemetry-32, for the same reasons.

Boca Research's SoundExpression 14.4VSp

The SoundExpression 14.4VSp (Boca calls it the SE1440) blazes its own trail. Rather than using one DSP to handle everything, the SE1440 employs discrete components, which explains why it's a full-length card. In specifications, it does nearly everything the DSP-based cards reviewed here will do. What you don't get is software upgradability.

You can connect four kinds of CD-ROM drives with internal audio cable support for each. Line in and out as well as microphone and joystick/MIDI jacks are standard. With only one RJ-11 jack on the card, Boca supplies an odd-looking splitter that lets you connect a handset as well.

Boca did a first-class job packaging the SE1440. A preinstallataion COM-port sniffer tells you how to set jumpers for the fax modem's I/O port and IRQ. All audio and CD-ROM parameters are then set in the well-designed installation program, which makes configuration effortless. Boca doesn't include the Sound System software, instead bundling MidiSoft's Sound Impression tools.

The real story behind the SE1440 is the FaxWorks software from SofNet. It makes the SE1440 the most powerful and capable telephony card in this review. FaxWorks' base of operations, the Communication Center, lets you see how many voice and fax messages you have at a glance. Its unified inbox has a twist: Tab headers let you browse among fax and voice, new and old, and incoming and outgoing messages with ease. With each of FaxWorks' multiple voice/fax mailboxes, you can set a per-mailbox disk-space limit. Your mailbox can also have its own private fax-on-demand list, and FaxWorks' forwarding options are impressive.

When you're traveling, FaxWorks can notify you about new faxes and voice messages by digital pager or by faxing a status update. In both cases, FaxWorks gives you the number of new and old fax and voice messages, and the total number of new fax pages. With pager notification, FaxWorks ingeniously turns this data into Touch-Tones. The counts appear in your pager's display as a suffix following any mailbox-specific ID code you supply. When you call in for your messages, you can also get your faxes selectively. And FaxWorks satisfies our fax-back standards by letting you call from any phone and specify a call-back fax-machine number.

The versatile FaxWorks gives you three ways to deliver fax-on-demand: 10 global demand documents, 10 additional documents per mailbox, and up to 1000 documents in a master document-retrieval tank. Each fax-on-demand document may contain several pages, and you can see both thumbnail and full-size views as you select documents for the list. The smaller global and per-mailbox fax-on-demand lists support both voice and faxable text descriptions, but the document-retrieval area requires the caller to know the four-digit document code and its four-digit password. As with fax retrieval, fax-on-demand supports both immediate and delayed transmission.

While not quite the equal of the voice prompts included with the Multimedia Connect software shared by the MediaMagic and AMI cards, FaxWorks' standard voice prompts and greetings are clean and professional. It has many nifty features. With a lightning-fast viewer, annotation, and automatic cover pages, the fax component is not crippled at all. The terminal emulator includes a host mode for quickie file transfers. If you get lost, you can turn on FaxWorks' "cue card" facility, which pops up a helpful hints window for the control you're pointing at.

The SE1440 card does have a quirk or two, including too-loud Touch-Tones while dialing and an ear-jamming pop that precedes local playback of greetings and prompts. Overall, however, we give the SE1440 top marks for the quality of FaxWorks.

As hardware, all the reviewed multifunction cards are capable enough for telephony; it's the bundled software that makes the difference. For now, the Boca SE1440 and the AT&T cards from MediaMagic and AMI provide the best business telephony software. ■

Tom Yager is a freelance writer and analyst living in north Texas. He is the author of The Multimedia Production Handbook for the PC, Macintosh, and Amiga *(Academic Press, 1993). You can reach him on the Internet at tyager@maxx.lonestar.org or on BIX c/o "editors."*

Where to Find

American Megatrends, Inc.
Norcross, GA
(800) 828-9264
(404) 263-8181
fax: (404) 263-9381
Circle 1147 on Inquiry Card.

Best Data Products, Inc.
Chatsworth, CA
(800) 632-2378
(818) 773-9600
fax: (818) 773-9619
Circle 1148 on Inquiry Card.

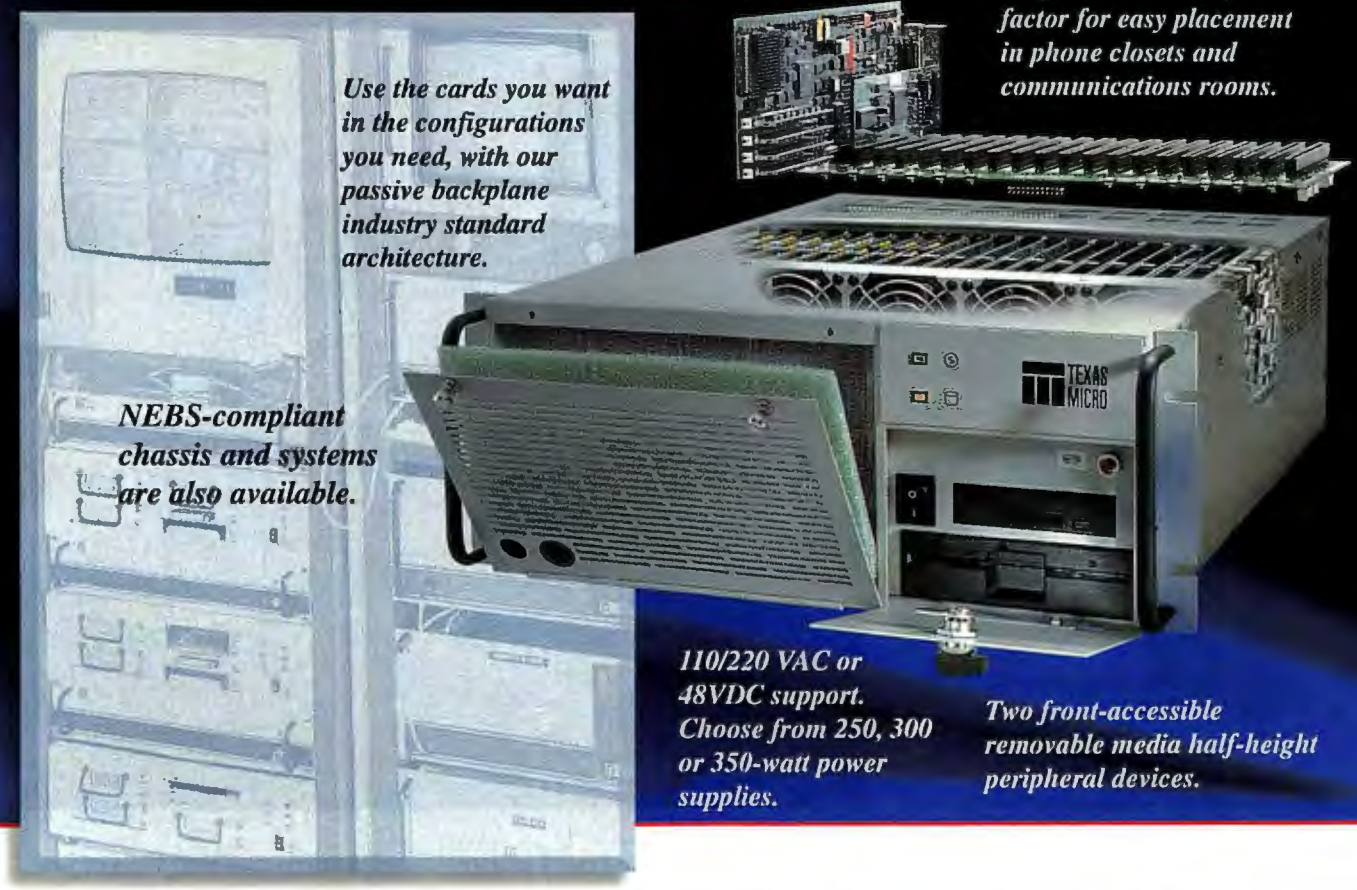
Boca Research, Inc.
Boca Raton, FL
(407) 997-6227
fax: (407) 997-0918
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MediaMagic
IPC Technologies, Inc.
Austin, TX
(800) 624-8654
(512) 339-3500
fax: (512) 454-1357
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Objix Multimedia Corp.
Waltham, MA
(800) 854-6211
(617) 466-8720
fax: (617) 466-8722.
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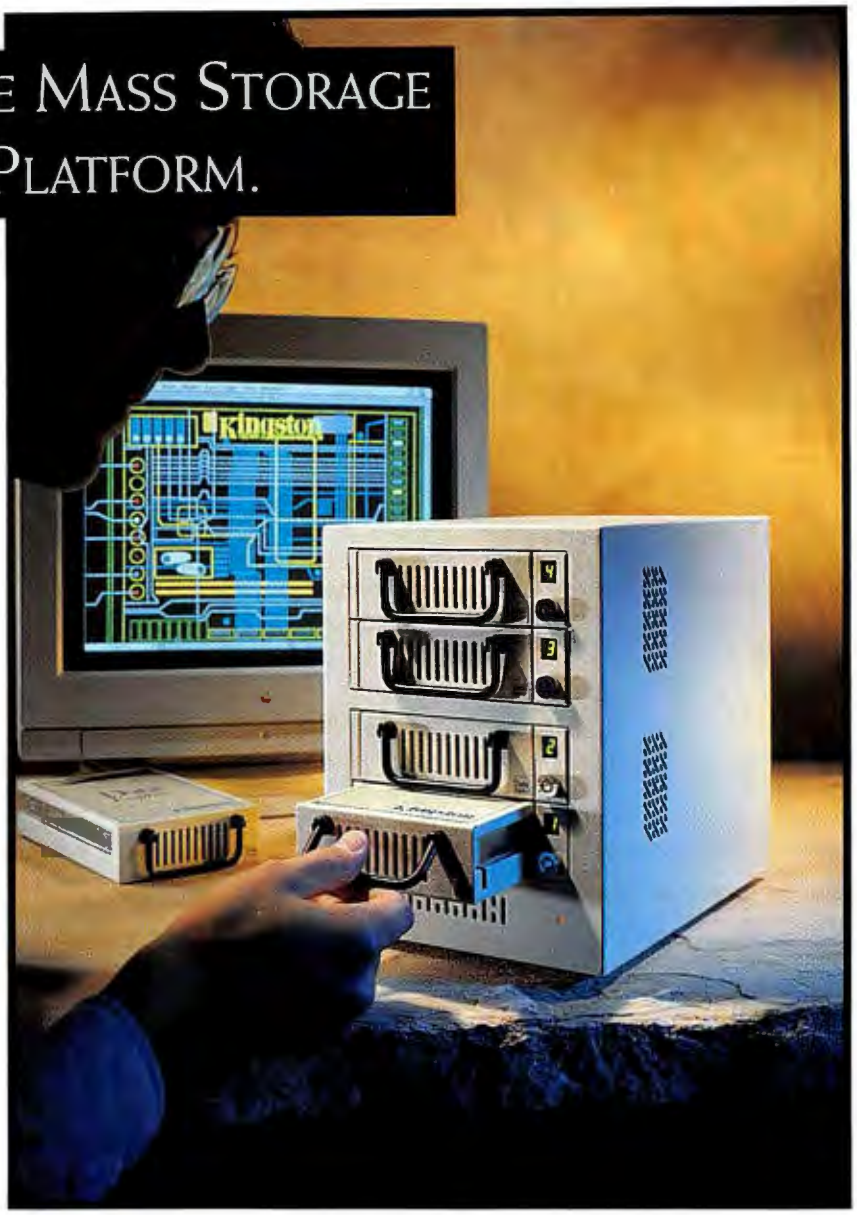
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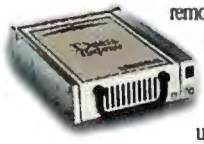
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Circle 292 on Inquiry Card (RESELLERS: 293).

Apple's Improved MessagePad

Bug fixes, more memory, and third-party peripherals and software have improved MessagePad usability

TOM THOMPSON

Apple's new MessagePad 120 strengthens the company's role in vertical applications. Although it still doesn't read handwriting the way we'd like it to, it offers more memory, better ROMs, and growing third-party support in the form of PC Card peripherals.

With a cursory glance at the MessagePad 120's hardware specifications, you might think it's the original with a flip-top cover for the LCD. It still uses a custom system ASIC to manage hardware subsystems, the same 20-MHz ARM610 RISC processor, and a Type 2 PC Card slot. But its 4-MB ROM features Newton OS 1.3—with bug fixes, improved handwriting recognition, and a larger dictionary (13,000 words instead of 10,000).

The MessagePad 120 comes in 1- and 2-MB memory configurations, whereas the MessagePad 100 had just 640 KB. This gives you up to 1.4 MB of RAM for applications and information (2-MB system) versus 220 KB in the original. The MessagePad 120's low-power reflective LCD is slightly smaller than the original's (320- by 240-pixel resolution versus 336- by 240-pixel resolution, respectively).

The MessagePad 120 is taller and longer but less wide than the original, so it fits into more jacket pockets. A larger battery cavity holds four AA batteries instead of four AAA batteries. That boosts the PC Card slot power rating from 110 to 325 milliamperes, enough to support modem cards for wireless communications.

Now for the price: The MessagePad 100, sans peripherals, cost $699. For the same price, you can get a MessagePad 120 with 2 MB of RAM and an external modem (2400-bps data and 9600-bps fax), which is the unit we tested here.

Field Test

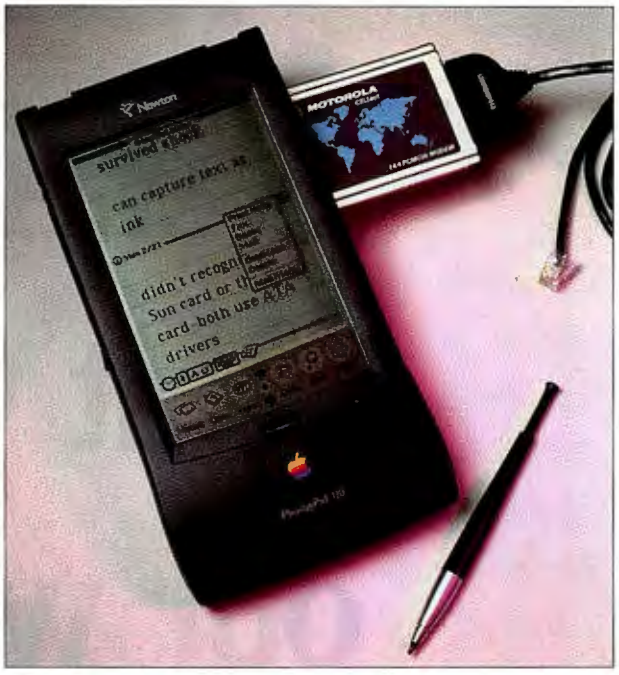
The MessagePad 120 comes preinstalled with Name and Date applications, as well as Notions 1.1, a PIM (personal information manager) application. Because the original MessagePad did a good job at recognizing my handwriting (a mix of cursive and printed text), it was hard to discern any improvement in that area. However, the MessagePad handwriting recognition engine now supports deferred recognition. This lets you rapidly jot down notes as "ink" or bit maps and capture them later as text—a big win for those using the MessagePad 120 as an electronic notepad.

The Newton OS has gained stability: During testing, we saw only one system error, and we never had to reset the device, despite inserting a variety of cards and downloading new software.

The PC Card situation is mixed. An Epson 2-MB memory card worked, but an Epson 20-MB flash memory card didn't. Neither did SunDisk's 1.8-MB FlashDisk card: We got an "Unrecognized type of card" message. Both cards use an ATA (AT attachment) interface for data I/O. PCMCIA storage cards that mimic IDE hard drives don't work with the MessagePad 120. The Newton OS isn't hard drive–based, so it doesn't understand them.

To use third-party PC Card modems with the 120, you must first download additional software from AppleLink or eWorld—a modem interface module and several "enablers" that transparently manage the messy modem configuration details for you. We downloaded the ModemEnabler package (a package is analogous to a file) and the enablers for a generic Hayes modem and the Motorola Cellect 14.4-Kbps cellular modem card. (A variant of the Motorola enabler lets the modem communicate through a MC2 Microtac cellular phone.)

We copied these files to a PC and used the Windows version of Apple's Newton Connection Kit to download the software to the Newton. After inserting a Motorola Cellect PC Card modem, we picked the appropriate enabler from the Preferences settings on the MessagePad. With a few pen taps, we could fax notes using the Cellect. Installing a terminal emulation program called PocketCall from Ex Machina, we could log on to BIX and other character-based on-line services at 9600 bps.



DENNIS WARNESKY © 1995

The new, slimmer MessagePad 120 fits more easily in a pocket. With 2 MB of RAM and third-party support, there are more reasons to put one there.

Product Information

MessagePad 120 ..... $699
(2-MB configuration with Newton fax/data modem and PocketQuicken)
(1-MB configuration) $599
Apple Computer, Inc.
1 Infinite Loop
Cupertino, CA 95014
(800) 776-2333
(408) 996-1010
fax: (408) 974-6412
Circle 977 on Inquiry Card.

Outlook: Good

For certain on-the-go business people, the MessagePad 120 is a handy communications device. Although the PC Card slot supports wireless communications devices, it's still too early to count on any wireless solutions other than a cellular phone hookup. However, the MessagePad is still best suited to specialty applications and getting better at it all the time. ■

Tom Thompson is a BYTE senior technical editor at large and an Associate Apple Developer. You can reach him on the Internet or BIX at tom_thompson@bix.com.



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Good News From Delphi

Borland's Delphi is a potent combination of Object Pascal compiler, visual development environment, and database tools

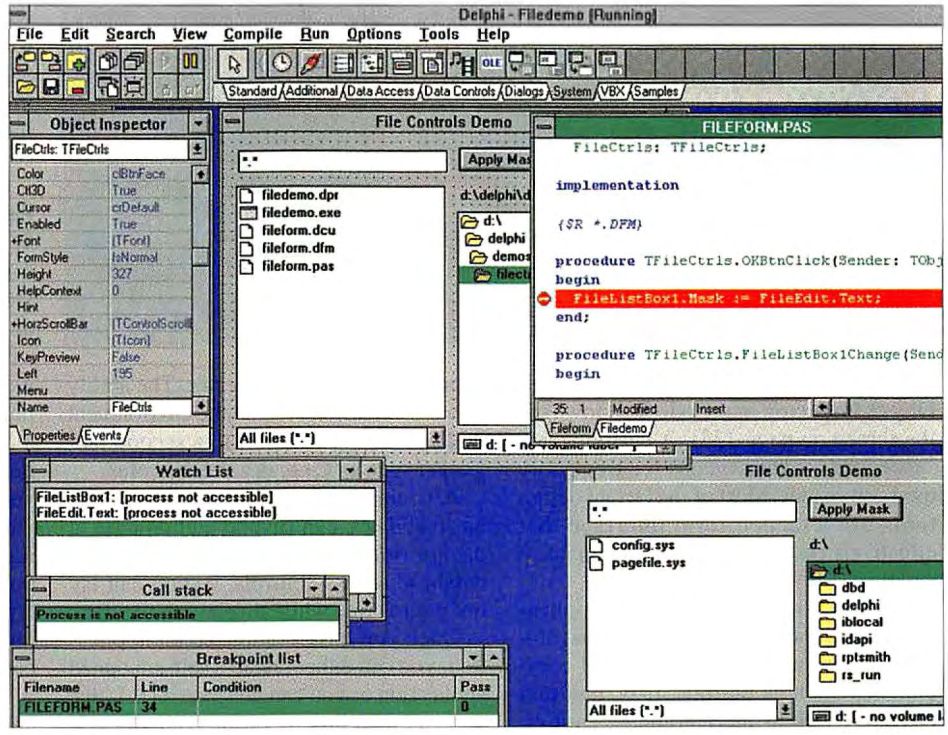
RAYMOND GA CÔTÉ

After more than 15 months of beta testing and nearly two years of buildup, Borland International has delivered Delphi, its entry into the RAD (rapid application development) marketplace. Windows-based Delphi consists of several tightly integrated components: an object-oriented Pascal compiler and debugger, a visual design environment, and strong database access tools. Borland designed Delphi as a tool to both develop prototype applications and convert them into commercial and corporate-grade products.

There are two versions. Plain old Delphi includes the development environment and the Borland Database Engine for access to dBase (several versions), Paradox, local InterBase, and ASCII tables, as well as other databases with ODBC (Open Database Connectivity) support. Delphi lets you generate stand-alone applications (not just database applications) and distribute them free of royalties. Delphi also comes with a single-user version of InterBase, Borland's SQL database server for Windows, but without license for distribution.

Delphi Client/Server ($1999) adds versioning control for development team support, built-in access to remote SQL databases (e.g., Oracle, Sybase, Microsoft SQL Server, and Informix) through Borland SQL Links 2.5, Interbase unlimited distribution license, and source code for Delphi's library of components. Delphi applications scale fully to Delphi Client/Server.

With the two versions, Borland is challenging low-end tools such as Microsoft's Visual Basic and high-end 4GL (fourth-generation language) products such as PowerSoft's PowerBuilder. Almost any development product introduced on the Windows platform today is either positioned as compatible with Visual Basic or as a VB-killer. On its merits, Delphi is certainly the latter and more. Whether or not Borland's RAD products pack enough power and performance to woo developers away from the Microsoft stable is another matter.



At the top are the elements of a typical Delphi development environment: the Component Palette, Object Inspector, Form Designer, and Code Window. At the bottom right is an executing program, and at the bottom left the Delphi debugging system. The program window demonstrates a live component at design time, a directory view component displaying the current status of the hard disk.

Old Friend Pascal

At Delphi's core is Borland's speedy object-oriented Pascal compiler. Pascal was Borland's original entry into the development tools marketplace and has not been a highly visible language over the last few years. The company has continued to develop and support it, however, keeping it up to date with support for all the latest operating-system niceties, such as DDE, MAPI, ODBC, and OLE 2.0.

If you are familiar with any other object-oriented language, you'll soon settle into Object Pascal. This is a single-inheritance object language with the features you expect, such as encapsulation and data hiding. The compiler provides extensive support for exceptions, a feature still lacking in many C++ compilers.

Borland claims its Pascal compiler is the fastest on the market, for any language. Although we didn't do any head-to-head testing, it is certainly fast enough. The application pops onto your screen soon after you select run from the development menu.

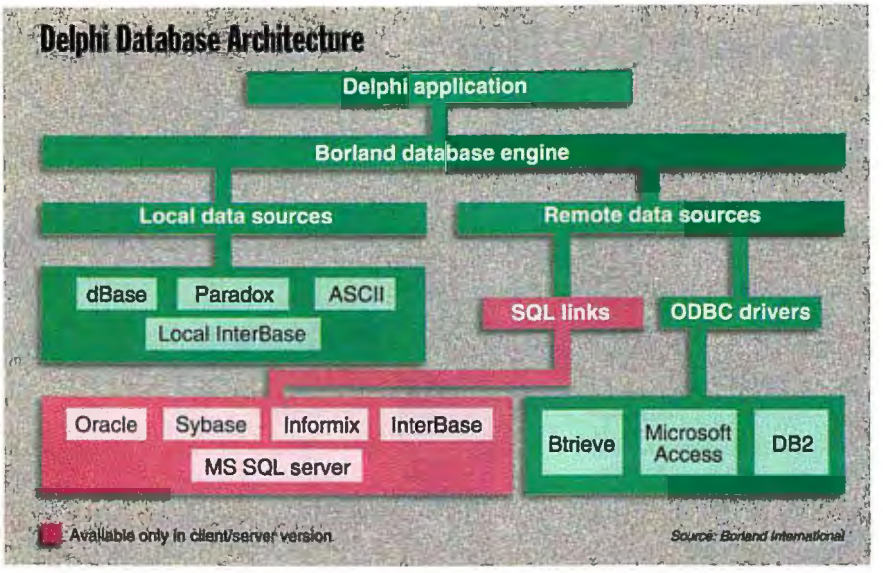
Coupled with the compiler is a source-level debugger with such niceties as conditional breakpoints. The debugger provides excellent viewing tools for looking through in-memory objects and tracing through function call stacks. The debugger does lack the ability to switch between source- and assembly-code viewing, an essential when debugging calls to system-level APIs.

Delphi Development Environment

The Pascal language is in many ways incidental to the Delphi development environment. Spend 5 minutes working with Delphi and you'll think you're working in Visual Basic. Spend 10 minutes and you'll realize that this is Visual Basic as it has appeared only in your dreams.

The development environment consists

Good News From Delphi



of the Component Palette, Form Designer, Object Inspector, and Code Window (see the screen on page 133). A customizable "speedbar" contains icons for frequently used commands. Most of the Delphi design tools use a tabbed form interface that effectively packs lots of information into a small space.

As with Visual Basic, Delphi applications consist of a series of forms. You compose a form with simple graphical components, such as buttons, lists, and text boxes, as well as more complex entities, such as custom-built Delphi Components, OLE 2.0 objects, and VBXs (Visual Basic custom controls). You select elements from the Component Palette, which is extendable, and place them in the Form Designer. You then set component characteristics via the Object Inspector.

Placing a graphical element on the Form Designer immediately produces a definition and associated functions in the Code Window. There you can add functionality to the code. Delphi has the unique ability to let you define a new graphical element as text in the source code and then paste that textual description into the form. This feature allows you to switch freely between a graphical and textual design environment, whichever is most suited to the task at hand.

Delphi is extensible. You can, for example, add third-party VBXes to the Component Palette. Developers can also create custom Delphi Components for in-house use or for sale. From the developer's viewpoint, custom components are indistinguishable from Delphi's built-in components. They appear graphically when placed on a form, and their attributes appear in the Object Inspector. The ability to build extensions within the environment without having to resort to a second language, such as C++, is a definite plus.

Also unique, Delphi components can be *live*: They can display actual data at design time. That capability extends to database access controls, so you can lay out your forms while displaying the data.

Once you have completed an application, you can either create a self-contained application or you can generate a DLL that you can then link to various other development tools. The smallest workable DLL, which includes the complete Delphi support library, seems to be about 250 KB. You don't need external DLLs unless your application uses third-party objects such as VBXes and ODBC drivers.

Database Access

Delphi applications perform all database access through the Borland Database Engine. This allows you to ignore, for the most part, what type of database a program accesses. However, if you know that you are going to specifically communicate with an SQL database, you can also build SQL-specific queries.

Both versions of Delphi come with a fully functional, single-user version of Borland's InterBase. This package lets you create and test SQL-based applications on local systems. Both versions supply ReportSmith, a sophisticated reporting and data extraction tool, but only the Client/Server version comes with a visual SQL query builder. Both these tools provide sophisticated access to local and remote database systems and complement the development environment.

Delphi rounds out its environment with tools for building icons, cursors, and simple bitmaps. Delphi also comes with integrated support for the PVCS 5.2 version control system from Intersolv (Rockville, MD (301) 230-3228). Unfortunately, this support comes with only the significantly more expensive Client/Server version; individual users also require versioning control for their projects.

Power Base

With its quick compiler, extensible environment, and integrated database access, Delphi is a powerful base for creating applications. The accessibility of VBX extensions and OLE 2.0 objects opens a world of third-party add-ons to the Delphi developer. The ability to create standalone applications, as well as self-contained DLLs provides ways to integrate your results with other applications. At the core of all this, add the delight of working again in Pascal—a language more powerful than Visual Basic—with strong typing and object extensions, and yet so much simpler and safer than the intricacies of C++.

In future releases, we'd like to see automatic garbage collection, integrated source-code control in the base version, and portability beyond Windows 3.1. Borland has plans to provide a 32-bit Windows 95 version whenever that operating system ships, but the company has no stated plans to provide support for additional platforms—something Delphi will need for long-term survival as a developer product.

At the very least, Borland has raised the level of functionality that developers should demand from their development tools. It remains to be seen how many developers Delphi will actually attract. Our guess is that anyone who spends more than two or three days working with Delphi will find returning to previous development tools difficult. ■

Product Information

Delphi **$495**
(90-day introductory price $199.95)
Delphi Client/Server **$1999**
Borland International, Inc.
Scotts Valley, CA
(800) 891-2223
(408) 431-1000
Circle 1002 on Inquiry Card.

Raymond GA Côté is a BYTE consulting editor and vice president of product development for Appropriate Solutions, Inc. (Peterborough, NH). You can reach him on the Internet at rgacote@apsol.com or on BIX as "rgacote."

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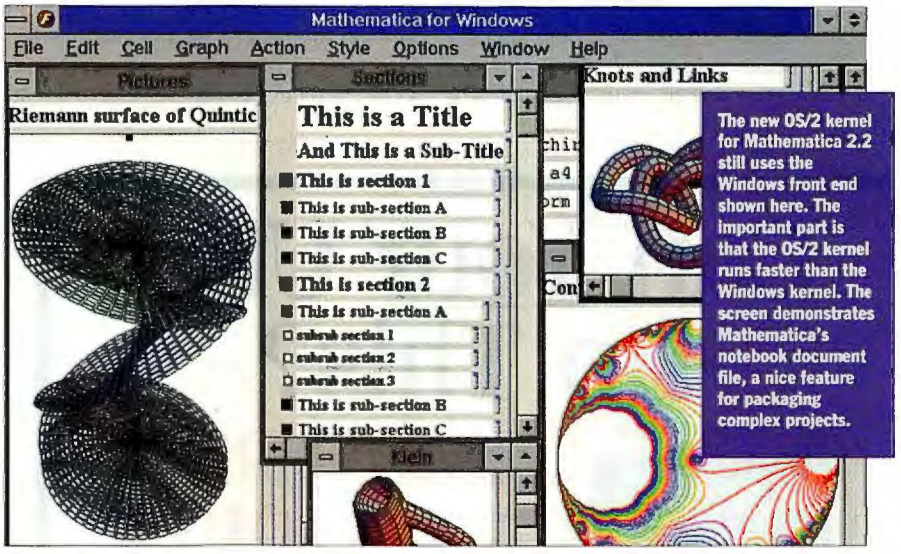
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Mathematica Meets Warp

OS/2 is a natural home for multithreading Mathematica 2.2

DOUG TAMASANIS



Mathematica has become an indispensable software tool for quantitative analysis. That's partly because it so effectively joins sophisticated computational and graphical capabilities under one roof, making it easier to visualize and predict the behavior of complex systems. With Mathematica's interpreted programming language, R&D, engineering, and business professionals can quickly work out solutions to highly customized problems that don't warrant the time commitment needed to develop simulations using C or FORTRAN.

Wolfram Research has ported Mathematica from its Macintosh origins to a wide range of platforms, including PCs (MS-DOS, Windows, and Windows NT), Unix workstations (Sun Solaris, SGI IRIS, and IBM AIX), and several larger systems. The latest port of Mathematica 2.2 is to OS/2 Warp. Now OS/2 users don't have to rely on the Windows version of the Mathematica kernel, which only simulates multithreading. The new release takes full advantage of the OS/2 preemptive scheduler, threading, and 32-bit flat memory structure to both improve performance and to greatly increase the size of the problems Mathematica can handle. We found the OS/2 version indeed faster than the Windows version and also more stable.

The OS/2 port still relies on the Windows graphical front end, however, which is fine. Mathematica's standard user interface is a command-line interface. Type in a Mathematica command, and it prints or displays the result. The Windows graphical front end is to the command-line interface what a word processor is to a line editor—a much easier way to achieve the same result. The Windows front end attaches to the OS/2 kernel using MathLink, Mathematica's communications protocol.

Unfortunately, the OS/2 version of MathLink wasn't out of beta when we tested the product, though it should be now. We couldn't link the graphical front end directly to the OS/2 kernel. For convenience, we developed our models to test OS/2 kernel performance with the Windows version of Mathematica, a somewhat less direct version of how you will use the product anyway. Wolfram Research will provide a free upgrade including OS/2 MathLink and the Windows front end.

No Pencil, No Paper

For such a powerful program, Mathematica's user interface (both command line and graphical) has surprisingly few elements cluttering up the main window. The interface is a little clunky because of Mathematica's client/server architecture. You type in a command, and the kernel interprets it and then opens one or more output cells containing numerical, symbolic, or graphical output, and any error messages.

For complex projects, Mathematica lets you create document files called *notebooks*, which can contain any mixture of text, graphics, and Mathematica input and output. Within a notebook, information resides in cells that you can move or copy within or between notebooks. With the Windows front end, you can also nest cells to create neat hierarchical structures, a great help in managing large reports with complex analyses. Brackets in the right margin indicate cells and their place in the hierarchy (see the screen). As with an outline processor, you can hide the contents of a group of cells by double-clicking on the grouping brackets in the right margin, collapsing several layers of work so that only the contents of the head cell are visible.

Mathematica's capabilities fall into three main classes—numerical, symbolic, and graphical—but there are other features that add to its richness. If your computer is sound capable, for example, you can express wave forms as sounds to gain insights that are visually hard to discriminate. Mathematica also has a control language for running external programs and processes, and it can serve as an embedded system that other programs can call.

At its basic level, Mathematica functions much like a calculator, returning an answer when you type in a calculation. However, the sheer number of available functions (over 800) beats any calculator and rivals the math libraries available for such programming languages as FORTRAN and C. There are functions for statistical analysis, Fourier analysis, numerical integration, and many other processes. Additionally, Mathematica handles objects such as matrices, performing matrix inversion and eigen systems.

On the symbolic front, Mathematica manipulates algebraic formulas. The program is handy for checking calculations involving factoring, expanding, and simplifying polynomials and for solving systems of equations. Mathematica can also check derivations involving derivatives and integrals and find solutions to ordinary differential equations. It is particularly useful in deriving power series approximations and limits (and quicker than thumbing

through your favorite mathematical standards and tables books).

Mathematica's outstanding graphics capabilities let you produce 2-D and 3-D plots, contour plots, and density plots. You can embed keywords in the plotting calls to control shading, color, lighting, viewpoints, and other parameters. For demonstrating time-dependent functions, Mathematica can produce animated graphics. Mathematica generates all graphics in standard PostScript format, making it easy to transfer output to other programs.

Creating Functions

Because Mathematica is based on an interpreted programming language, it has great power and flexibility. You can add an unlimited number of extensions to an already impressive list of functions. It's also far quicker and simpler than using FORTRAN or C with such external math libraries as IMSL or AMOSLIB.

Mathematica stores less frequently used functions in files called packages (e.g., Calculus, Graphic, and Number Theory) that you load as needed. You can load individual functions or an entire package.

An added prize is MathSource, a library of programs that you can download free of charge. MathSource includes 1700 items developed by Mathematica users and Wolfram Research: function packages, notebooks, research papers, examples, and programs written in Mathematica. Items of interest available in MathSource include a signal-processing package, neural network analysis routines, microeconomics analysis routines, a symbolic control system analysis package, and a 2-D animation of Schroedinger's equation. A CD version of MathSource ($45) contains all files available on-line.

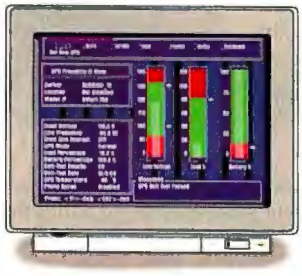
Once Wolfram Research provides MathLink communications protocol support for the OS/2 Mathematica, you'll be able to access Mathematica remotely over TCP/IP and use the Windows front end. The OS/2 version of the MathLink libraries will let you integrate Mathematica with programs written in C and FORTRAN. Also available are MathLink extensions for other applications (some free from MathSource, some not) that allow exchange of data and expressions between a Mathematica kernel and other applications. Because of the newness of Mathematica for OS/2, however, there isn't the same selection as with other versions.

Version Variance

We compared performance between the Windows and OS/2 Warp versions of Mathematica 2.2 on a 90-MHz Pentium with 16 MB of RAM and a 1-GB hard drive. We used several common functions, some exotic functions, and several complex Mathematica programs downloaded from the MathSource repository. In particular, testing consisted of calculating and plotting special functions (e.g., Bessel, gamma, and zeta); loading and manipulating large (200 by 200) and small (10 by 10) matrices; performing signal analysis and Fourier transforms; and executing several large programs (icosahedral sphere, five octahedra inscribed, and other exotic and common programs). We performed and timed all calculations with the Windows and OS/2 versions of Mathematica, and we also ran the Windows version under OS/2's Win32 emulation mode.

As expected, the OS/2 Warp version ran faster than the Windows version,

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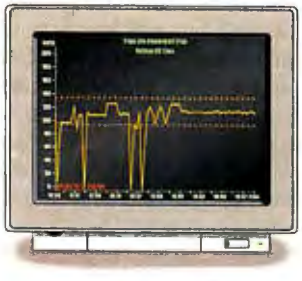
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although Warp's speed wasn't apparent for many of the codes we tested. A few performed much faster, but on average, we realized only about a 25 percent decrease in execution time with the OS/2 version. For example, the generation of a 65,536-point time-domain noise signal and subsequent transformation into the frequency domain via a Fourier transform took 8 minutes and 29 seconds in the Windows version and only 7 minutes and 54 seconds in the Warp version. The calculation and plotting of Bessel, gamma, and zeta functions had essentially identical results.

When we spawned multiple instances of the same test, execution times for codes running under Windows suffered significant performance degradation relative to the number of processes. The OS/2 version suffered far less performance degradation when multiprocessing. This is an expected result due to the nature of OS/2 Warp and Windows for WorkGroups.

Product Information

Mathematica 2.2 for OS/2 . . . . $995
Wolfram Research, Inc.
Champaign, IL
(800) 441-6284
(217) 398-0700
fax: (217) 398-0747
E-mail: info@wri.com
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One Mathematica program that crashed under the Windows version ran successfully with the OS/2 version (the program came from MathSource). The Windows version of Mathematica ran faster overall in Win32 emulation under OS/2 Warp than it did under Windows for Workgroups 3.11. Additionally, the code that crashed under Windows for WorkGroups ran in the Win32 emulation mode under Warp. OS/2 is impressive.

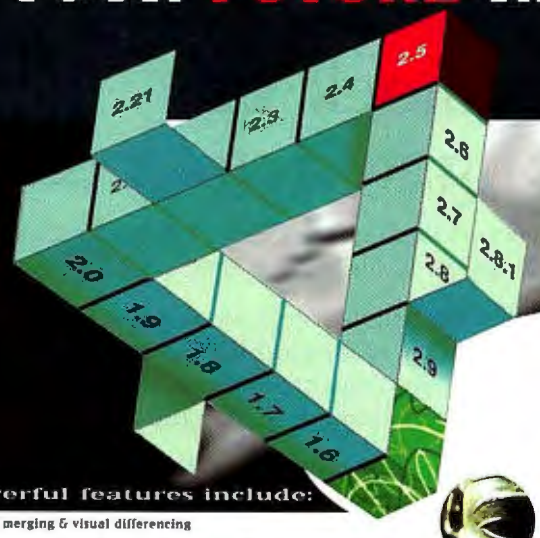
Calculating the Sum

Laudably, Wolfram Research discusses Mathematica's limitations frankly in the manual with the intent of helping the user solve a problem. During testing, for example, we got a wrong result from a numerical integration calculation of a function with a singularity. Mathematica issued a warning that there was an error involving a singularity, oscillatory integrand, or insufficient precision. Apparently, the integration scheme can only search for singularities at the end points of the integration region, and the presence of other singularities results in reporting erroneous data. The manual, however, contained a detailed discussion of the algorithm, and when we explicitly identified the location of the singularity and restarted the program, we got the correct results.

Mathematica is a superior tool for analysis of complex systems. The OS/2 Warp version of Mathematica 2.2 proved itself stable and fast. Although Warp's 25 percent overall performance gain over Windows isn't tremendously significant, it is welcome. If you need high-level programming for quick development, a large repository of application programs, numerical and symbolic manipulation, compatibility with C and FORTRAN, and visualization tools all in one package, Mathematica for OS/2 is a good choice. ■

Doug Tamasanis is a BYTE senior technical editor with a BS and MS in radiation physics and an MS in systems engineering. You can reach him on BIX as "dtam" or on the Internet at dtam@bix.com.

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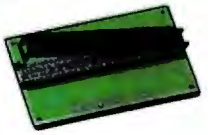
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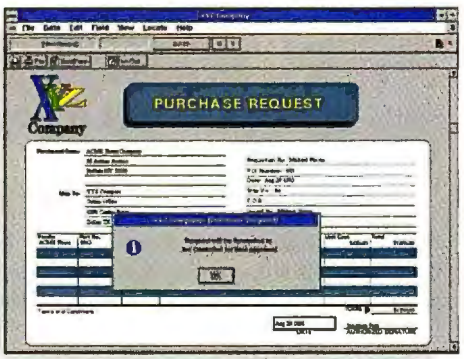
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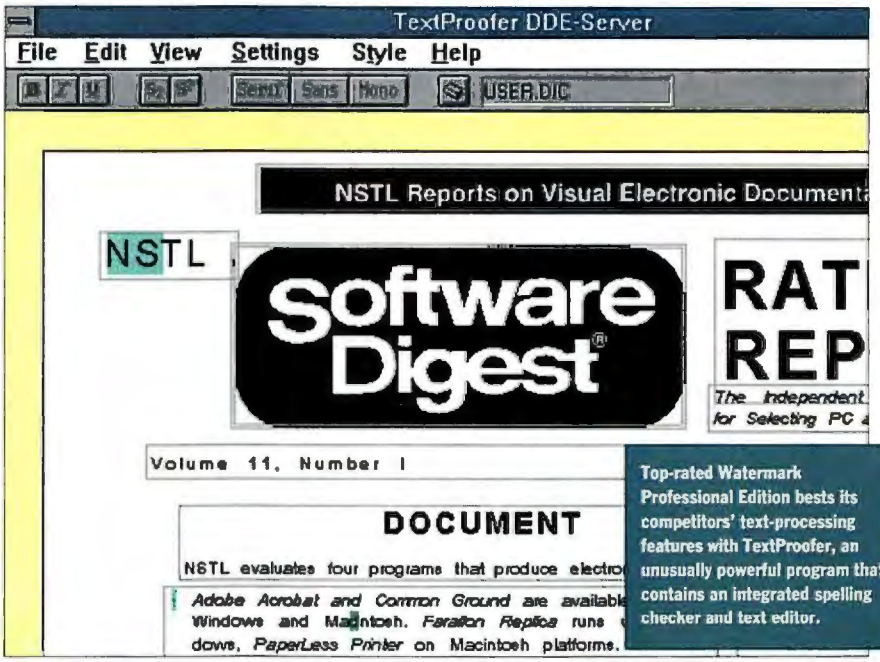
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Document Image Managers

Although standards are in flux and product categories are blurred, one of these eight packages may be just right for electronically managing your most important documents

DAVID SEACHRIST



Top-rated Watermark Professional Edition bests its competitors' text-processing features with TextProofer, an unusually powerful program that contains an integrated spelling checker and text editor.

Interest in using desktop computers to manage intellectual property has taken the personal computer industry by storm. In many organizations, documents are replacing applications as the central user-interface metaphor.

Not surprisingly, a whole broad category of document management software has risen to serve this growing demand. However, despite some marketing claims, no one product can meet everyone's document management needs. In fact, we can divide document management into three subcategories:

- *Dynamic document management* software (sometimes called ad hoc document management) focuses largely on managing documents that are still in the creation, editing, or production stages. Products such as PC Docs Open, SoftSolutions, Visual Recall, and WorldView fall into this category.
- *Document image management* deals with managing documents that are already complete, making content creation and formatting control moot.
- *Document exchange programs* focus largely on making electronic documents more portable. The goal is to reduce handling of paper documents by using formatted electronic versions that you can open and print in different applications. Adobe Acrobat, Envoy, Replica, and Common Ground are in this category.

For this software roundup, NSTL focused on document image management for Windows environments. Also, the reviewed products must run as native applications under Windows, support scanning on a Hewlett-Packard ScanJet IIc, perform OCR, allow search and retrieval using the Boolean and operator, provide a go-to-page tool for quick document navigation, and allow printing.

Rating Usability

NSTL used a document library of 17 issues of *Software Digest Ratings Report* as the basis for testing the eight programs' ease of learning and use in basic functions, such as scanning, OCR, indexing, searching and retrieving, and printing. In addition, NSTL rated the programs for usability in installation, documentation, library setup, and maintenance. In general, the programs that provided the best interface

OVERVIEW

NSTL RATING		VERSION	PERFORMANCE	QUALITY	VERSATILITY	EASE OF LEARNING	EASE OF USE	PRICE
★★★	Watermark Professional Edition	1.0	▼	▲	■	▲	▲	$295
★★	FileMagic Plus	4 series	▼	■	■	▲	▲	$1795
★★	PageKeeper	1.1	▼	▲	■	▲	▲	$595
★★	ImageFast	2.0	▲	■	▲	■	▲	$695
★★	FileFlo	3.6	▲	■	■	▲	▲	$795
★★	Recollect	2.11	■	▼	■	▲	▲	$595
★★	Equip+	6.0	■	■	▼	▲	■	$249
★★	PaperClip for Windows and Isys	3.0	■	▼	▲	■	■	$695

KEY

★★★★★	Outstanding
★★★★	Excellent
★★★	Average
★★	Below average
★	Poor
▲	Good
■	Fair
▼	Unacceptable

Highlights

	Strengths	Limitations
Equip+	• Form fill-in feature • Strong OCR feature support • Fax send/receive driver included	• Cannot view page during batch scans • Limited document indexing • Limited document retrieval
Fileflo	• Numerous OCR features • Fast retrieval • Good print and fax output quality	• No automatic full-text indexing • Unsatisfactory OCR quality • Limited work-flow support
FileMagic Plus	• Numerous indexing features • Easiest to use • OLE 1.0 client/server support	• Limited number of OCR features • Unsatisfactory OCR quality
ImageFast	• Numerous scanning features • Fast retrieval speed • Strongest work-flow support	• Confusing indexing functions • Limited OCR support • Unsatisfactory OCR quality
PageKeeper	• Displays relevance of search results • Integration of scanning, OCR, and indexing • Excellent OCR quality	• Can't set resolution during scanning • Limited links to other applications • Limited image-editing support
PaperClip for Windows and Isys	• Numerous scanning features • Good proprietary links to other applications • Strong retrieval feature set	• Most difficult to learn and use • Poor OCR quality • Poor print quality
Recollect	• Easiest to learn • Integration of scanning, OCR, and indexing • Displays relevance of search results	• Limited links to other applications • Poor OCR quality • Slow retrieval
Watermark Professional Edition	• Good documentation and user interface • Scanning, OCR, and image features • OLE 1.0 and 2.0 client/server support	• Limited indexing features • Limited retrieval features • Slow retrieval without database server

design and documentation were the ones that rated highest in NSTL's usability evaluations. Westbrook Technologies' FileMagic Plus 4 Professional, Caere's PageKeeper 1.1, MindWorks' Recollect 2.11, and Watermark Software's Watermark Professional Edition 1.0 all achieved better-than-average usability.

Recollect was the easiest to learn. It has an intuitive interface and documentation that is short, well designed, and to the point. The biggest factor in its ease of learning is that many of its processes are automatic and don't require separate steps.

A lack of functions also makes some programs easier to learn. Reduced feature sets often translate into shorter learning curves while causing a corresponding drop in ease of use. Such is the case with both Watermark Professional and Alacrity Systems' Equip+.

PageKeeper is like Recollect in combining OCR and indexing in a single process. However, installing PageKeeper requires more decision points than seems necessary, and its library setup is not as easy as Recollect's.

The tutorial in Newport Canyon Associates' Fileflo 3.6 is too bound to the manual and gives short shrift to key topics like OCR and document indexing. Furthermore, Fileflo's installation process is longer and requires the most decision making of any of the tested programs.

FileMagic Plus has the best learning materials, with separate tutorials for systems administrators, database administrators, and users. However, its problematic installation included false low-memory reports and an incorrect password sequence. (Westbrook Technologies promptly provided a maintenance release to fix these problems, but we had to reinstall the software.) In addition, library setup and indexing of documents were harder to learn than in the other programs.

The tutorial in ImageFast Software Systems' ImageFast 2.0 covers starting the program, opening and creating drawers and folders, scanning, and indexing via standard forms, but it offers no coverage of OCR. The biggest learning difficulties result from the program's two separate indexing and search engine options. This requires more study than the programs with a single indexing and search engine.

PaperClip Imaging Software's PaperClip for Windows has a tutorial that covers scanning, setting up applications to work with PaperClip, viewing images, and retrieving documents. It offers no coverage of OCR and little on how to set up folders and drawers. Both OCR and library setup are difficult to learn.

Ease of Use

FileMagic Plus's interface amenities and flexibility make it one of the two easiest programs to use. We were particularly impressed with the program's search interface and OCR options, both of which let you select the storage location of text within document files.

Watermark Professional's user interface also makes it a winner in ease of use. Although its search engine and limited indexing options are weak, its help system and OCR interface are the best of any of the programs.

We found Recollect and PageKeeper to be slightly harder to use than Watermark Professional or FileMagic Plus. Neither program allows naming and saving of search criteria the way Watermark Professional and FileMagic Plus do.

Fileflo's indexing capabilities are less flexible than those of some of the other programs, and although it lets you save search criteria, its search interface is not as intuitive as the interfaces of other programs.

With ImageFast, you have to switch search engines, choosing either the internal search engine or the run-time version of Microsoft Access's Database Wizard, depending on the type and speed requirements of the search. This is cumbersome.

Equip+'s lack of a search engine and its scanning and OCR interface make it less flexible for volume document scanning and indexing than most of the other programs. Finally, the lowest rated product for ease of use, PaperClip for Windows, has a cumbersome OCR function, and its indexing routine takes too many steps.

Scanning Horizons

Scanning is the method by which these programs transform documents into images, graphical bit maps that act as snapshots of the documents' pages. Two issues are important here: breadth of support of

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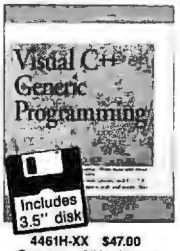




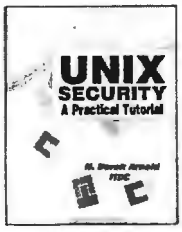
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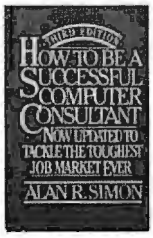
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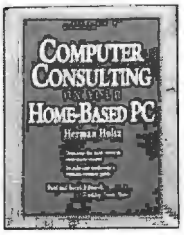
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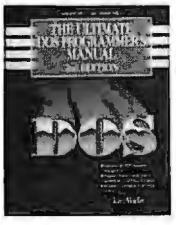
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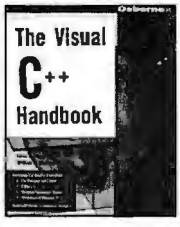
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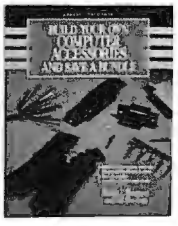
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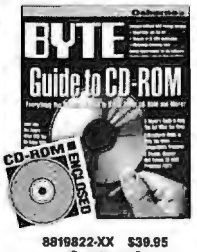
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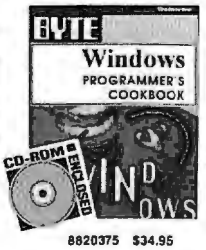
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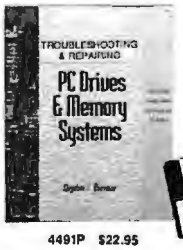
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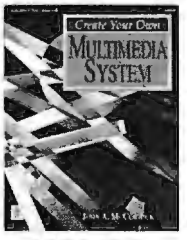
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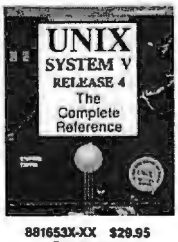
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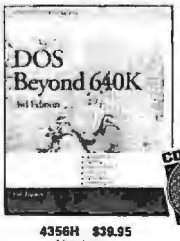
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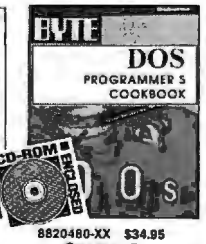
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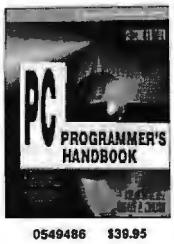
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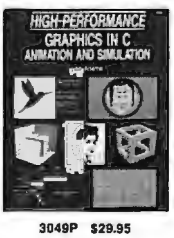
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SCANNING AND FILE MANAGEMENT FEATURES

	EQUIP+	FILEFLO	FILEMAGIC PLUS	IMAGEFAST	PAGEKEEPER	PAPERCLIP FOR WINDOWS AND ISYS	RECOLLECT	WATERMARK PROFESSIONAL EDITION
SCANNING								
Number of scanners supported	25	75+	24	60+	60+	60+	50+	100+
Monochrome/dithered/gray-scale/color images	MD	MD	MDGC	MD	M	MDC	MDGC	MDG
File compression	●	●	●	●	●	●	●	●
Document feeder support	●	●	●	●	●	●	●	●
View page during batch scan	○	●	●	●	○	●	●	●
Skew correction	○	○	○	●	○	●	○	●
OCR								
OCR engine	Calera	Calera	Calera	Calera	Caere	Ligature	Calera	ExperVision
Manual recognition zone selection	●	●	●	●	●	○	●	●
Automatic recognition zone selection	●	●	●	●	●	●	●	●
Optional spelling checker during OCR	●	○	○	○	●	○	○	●
Save recognized text in word processor formats	●	●	○	○	●	○	○	●
DOCUMENT INDEXING								
Manual indexing	●	●	●	●	●	●	●	●
OCR-driven indexing	●	●	●	●	○	●	○	○
Automatic full-text indexing	○	○	●	●	●	●	●	○
Index using saved templates/forms	○	○	●	●	○	●	○	●

● = yes; ○ = no. Note: Features not integral to the main program or bundled programs are marked no.

scanner types and image formats and the ability to control scan quality.

Although some programs ship with more scanner drivers than others, support for different brands of scanners is generally good in all the programs. The Scanning and File Management Features table shows the approximate number of scanners supported by each program.

Features like image file compression, document feeder support, and the option to designate a separator page (usually a blank page) as the division between documents when performing batch scanning are available in all the products. These features are important in environments that require scanning multipage documents or that have a high volume of single-page documents.

Support for scanning gray scales and color images into documents varies among the programs, and only Recollect and FileMagic Plus currently support both (Watermark Software planned to release a version adding color support to Watermark Professional in April). Regardless, many of the OCR modules only work with black-and-white images.

Watermark Professional, ImageFast, and PaperClip for Windows all correct skewed pages. Deskewing slightly shifts pages that are placed improperly on the scanner flatbed.

PageKeeper does not permit adjusting the scanner resolution, which determines the level of image detail; the higher the resolution, the greater the image detail. Resolution also affects image storage size and quality, so it is useful to be able to alter this setting.

PageKeeper and Equip+ lack the ability to view individual pages during the scan operation. This option is useful for seeing each page during a batch scan to determine whether any pages need to be rescanned.

More than OCR

The ability to change a page image into editable text directly affects the types of documents a document image manager can process. The most important feature for streamlining the OCR process is a program's ability to differentiate between the graphical and text portions of a page.

Some programs' OCR modules come with the ability to detect snaking columns and maintain the reading sequence of the text. Of the eight, ImageFast and FileMagic Plus do not. It is also useful to be able to compensate for tabular matter, such as tables of numbers, by inserting tabs or other delimiting characters between values. PaperClip for Windows, ImageFast, and FileMagic Plus lack this ability.

Beyond page formatting is text-character formatting. Some programs attempt to maintain formatting characteristics, such as boldfacing, and others simply maintain the text and lose all the formatting attributes. The OCR modules in Equip+, Fileflo, PageKeeper, and Watermark Professional come with file format conversion filters that allow saving text and formatting in popular word processor file formats.

Despite the fact that virtually every computer user has a word processing program with a spelling checker, Equip+, PageKeeper, and Watermark Professional offer an optional spelling checker as a part of their OCR operations. Watermark Professional's TextProofer program is especially powerful, containing an integrated spelling checker and text editor.

Indexing: The Crux of the Matter

Once a document has been scanned and saved as an image file and OCR has been performed, the next step is to identify the document so it will be easy to find. This process is called *indexing*.

The simplest indexing option is to name the document and attach fields that contain information about the document. Such manual indexing is available, using varying methods, in all the programs.

Fileflo, FileMagic Plus, ImageFast, PaperClip for Windows, and Watermark Professional provide multiple fields that users can customize with names and data types. Watermark Professional is the least

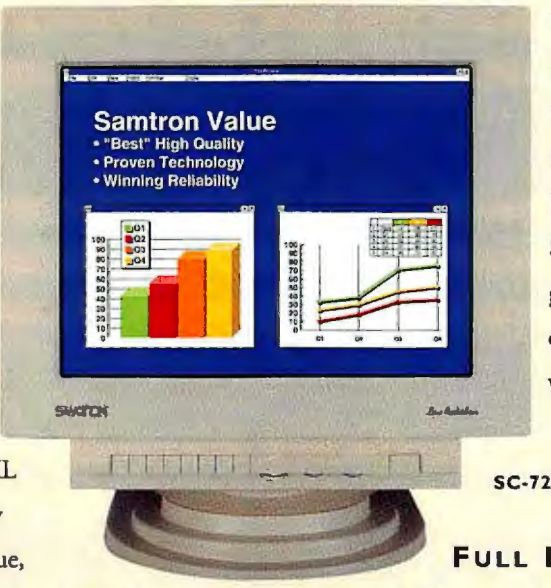
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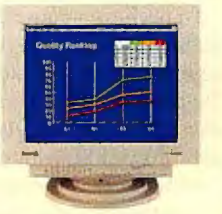
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DOCUMENT EDITING AND RETRIEVAL FEATURES

	EQUIP+	FILEFLO	FILEMAGIC PLUS	IMAGEFAST	PAGEKEEPER	PAPERCLIP FOR WINDOWS AND ISYS	RECOLLECT	WATERMARK PROFESSIONAL EDITION
DOCUMENT IMAGE EDITING								
View page image and text simultaneously	●	●	●	●	○	●	●	●
Annotate with bit-map drawing tools	●	○	●	○	○	○	○	●
Annotate with attached text	●	●	●	●	●	●	●	●
Copy/cut/paste page	●	[1]	●	[1]	[1]	○	[1]	●
Maintain document statistics	○	●	●	○	○	●	●	●
RETRIEVAL								
By full text or by notes/comments/index fields	[2]	[2]	●	●	●	●	●	[2]
Fuzzy searches	●	●	●	●	○	●	●	○
Boolean searches	●	●	●	●	●	●	●	●
Specify precision of search algorithm	○	○	○	●	○	●	●	○
Proximity searches	○	○	○	●	○	●	○	○
Save search results as a new file	○	○	●	[3]	●	●	●	●
Rank search results	○	○	○	●	●	●	●	○
WORK FLOW								
Routing	○	○	●	●	●	●	○	●
Access MAPI- and VIM-compliant E-mail systems	○	○	●	○	○	○	○	●
Additional, proprietary E-mail for short notes	○	○	○	●	●	●	○	○
Inbox or outbox for routed document images	○	○	●	●	●	●	●	●

● = yes, ○ = no. Note: Features not integral to the main program or bundled programs are marked no.
[1] Copy only.
[2] Retrieval by attached notes/comments/index fields only.
[3] Only in forms-based searches.

flexible in this regard, leaving most of this function to a database server that can be connected at an additional cost.

To perform manual indexing in Recollect and PageKeeper, you assign tag notes, the electronic equivalent of sticky notes. The problem with using tag notes is they are a haphazard means of indexing compared to fields, which prompt users for specific types of information. Equip+ allows filenames that are restricted to the DOS 8.3 naming scheme. In addition, each file has a single description field that can contain up to 127 characters.

The way OCR modules and indexing functions communicate is key to the types of documents suited for processing by each program. NSTL separates OCR and indexing integration into two distinct levels of functionality: OCR-driven and automatic full-text indexing.

Products with OCR-driven indexing are capable of capturing OCR data and placing it in appropriate fields during indexing. Because OCR-driven indexing uses fields as its organizing technique, it is the best indexing method for forms-based applications. Equip+, Fileflo, FileMagic Plus, ImageFast, and PaperClip for Windows provide OCR-driven indexing. Equip+ is hampered by the fact that it has only one field into which it can receive data. The other programs can direct OCR processed text into multiple fields.

Automatic full-text indexing involves indexing all the text captured during the OCR operation without using fields. Indexing an entire document's content for retrieval is best done with full-text indexing. FileMagic Plus, ImageFast, PageKeeper, PaperClip for Windows (via its bundled full-text, indexing add-on Isys) and Recollect offer this option.

Search and Retrieve

To locate documents, document image managers need powerful search tools that are easy to use. Programs like PageKeeper and Recollect can be helpful to researchers because their search modules rank results and use graphics to home in on appropriate data. This approach is not as useful for form retrieval, where it's important to locate the exact numbered form, not a range of close approximations.

In programs with full-text indexing, you should look for features like fuzzy searching, proximity searching, and ranking and sorting of search results. Fuzzy searching is the ability to set how closely the search results must adhere to the spelling of the search criteria. Proximity searching is looking only for documents that contain two words within a certain location of each other in the document. ImageFast and PaperClip for Windows (via Isys) are the only full-text indexing programs that support proximity searches. PageKeeper is the only full-text indexing program that lacks fuzzy searching. FileMagic Plus lacks the ability to rank search results.

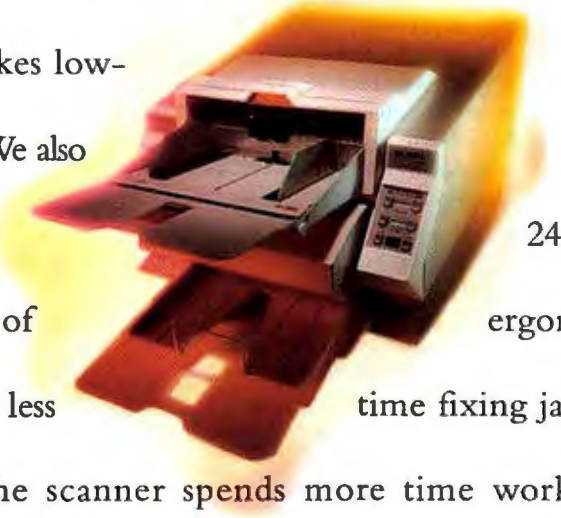
Boolean operators (`and`, `not`, and `or`) allow fine tuning or broadening of search criteria by including or excluding documents based on one or two search words. All eight programs allow this type of searching to some extent. However, Watermark Professional can only perform `and`-style Boolean searches on keyword fields and date fields. Equip+ and PageKeeper do not allow the `not` operator. Fileflo allows `not` in keyword searches but not for searches of document index fields.

Image Manipulation

All the programs allow viewing of the OCR processed text and the image of a page in side-by-side windows (except for PageKeeper, which offers viewing of the image or the text but not both at the same time). All also have ample magnification and navigation tools for zooming in on portions of pages or jumping to specific

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pages within documents. Each program also allows attaching note text to a page.

However, if you want to draw images on the page, your options are more limited. Equip+, FileMagic Plus, and Watermark Professional are the only programs to provide adequate bit-map painting tools. FileMagic Plus and Watermark Professional even offer highlighting pens to visually draw attention to important passages. ImageFast provides users with the ability to draw rectangles, and PaperClip for Windows can link to a third-party paint application.

The Distribution System

Once you view a document and perhaps attach a note to it, you would then either put the document away, print it, or pass it on to another person. Work flow is the term given to this routing of documents to other workers on your network.

ImageFast provides its own E-mail and distribution module called WorkFast. In addition to allowing documents to be distributed to other users' mailboxes, WorkFast lets you send E-mail, attach priority to documents, and mark them regarding their completion status.

A special network version of PaperClip for Windows provides the same capabilities as WorkFast minus the status feature. The status marking capability was to be a part of a PaperClip for Windows Workflow add-on planned for release in April.

FileMagic Plus and Watermark Professional offer routing and the ability to access MAPI and VIM-compatible (Vendor-Independent Messaging) software, which, in turn, allows access to Lotus Notes. PageKeeper offers routing and its own E-mail system. Equip+ uses an inbox/outbox metaphor to send and receive faxes. It is the only program to come with its own fax/modem driver software, and you can set it up to receive and send faxes unattended. All other programs use a fax driver, such as Delrina Software's WinFax, to send and receive faxes.

The Wider World

At some point, users will want other Windows applications to dynamically interact with their document image manager. But our findings in that regard are rather disappointing. Only two of the programs are able to act as OLE clients and servers: FileMagic Plus and Watermark Professional. Of these, only Watermark Professional supports OLE 2.0. DDE links are supported in Equip+, FileMagic Plus, ImageFast, and Watermark Professional.

PaperClip for Windows provides its own proprietary method of linking to other applications. Although this method works, testers found that text formatting was not maintained when linking the OCR module to a Windows word processor.

Equip+ and FileMagic Plus provide print-file drivers that allow printing from other Windows applications to a file in the document image manager's file format. After printing a Microsoft Word for Windows document to the file driver, for example, you can view the Word document in the document image manager exactly as if a scanner had scanned it.

Watermark Professional can hook up in a client/server environment. It offers an image-server product based on Microsoft

Product Information

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Filefio 3.6 ..... **$795**
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Circle 979 on Inquiry Card.

FileMagic Plus 4 Professional **$1795**
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SQL Server for Windows NT ($2995 for the 25-user version). And PaperClip for Windows offers an SQL Server version ranging from $595 to $995 per seat, depending on the number of seats. ImageFast and FileMagic Plus plan to offer tie-ins to database servers in future releases.

No Clear Winner

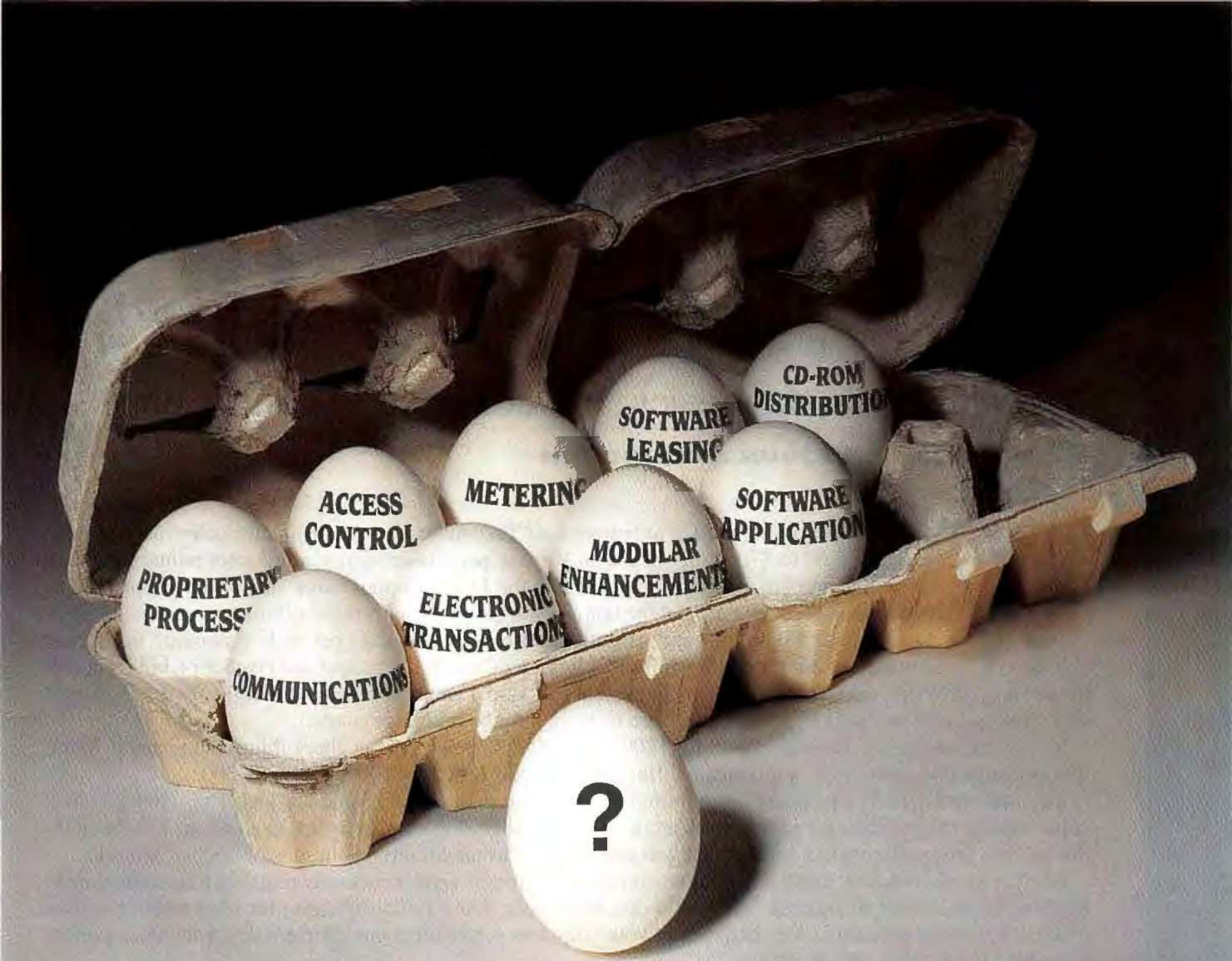
Document management standards are still too much in flux and technologies are not defined well enough to pick any of the evaluated products as the clear choice for handling all document-imaging needs. But the technology is taking off fast, and three of the tested programs are worth serious consideration for any company's initial foray into document image management.

Watermark Professional is a good introduction to the category. It has an elegant interface, well-written documentation, superior OCR, and a bevy of image manipulation tools. For example, it can easily handle price lists, and when paired with a third-party database server, it emerges as the best bet for forms processing. However, unless you already have or intend to install a database server, think twice about using Watermark Professional in a high-volume forms-processing environment: Its retrieval times are slow.

PageKeeper is worth considering for handling documents that require full-text indexing, such as customer service literature. Its streamlined processing of scanning, high-quality OCR, and full-text indexing, along with its ability to highlight the relevance of search results, makes PageKeeper well suited to applications that require information access and image retrieval.

FileMagic Plus has a good interface and documentation and a nice mix of functions. It doesn't offer the OCR quality of some of its competitors, but if you are looking for a compromise between the forms prowess of Watermark Professional and the full-text retrieval of PageKeeper, FileMagic Plus fits the bill. ■

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Circle 112 on Inquiry Card.

HANDS-ON TESTING

29 PRINTERS THAT

Concentrate on the basics, but add color to get the edge

MICHELE GUY AND JOHN MCDONOUGH

Waiting for the printer market to bottom out? Take note: You can buy a nice color ink-jet printer in the $500-to-$700 range or a 6- to 10-page-per-minute monochrome laser printer for about twice that amount. Workgroup printers in the 11- to 30-ppm range vary widely in price, depending on their features and the options you select. Laser printers offering more than 10 ppm typically provide minimum resolutions of 600 by 600 dots per inch, automatic input and emulation switching, support for PCL (Printer Control Language) and PostScript, bidirectional monitoring software, and remote-printer-management software. Features previously found only in very high-end printers, such as multiprotocol printing, are drifting into the midrange market.

Many vendors are introducing support for 1200- by 1200-dpi resolution, but check things out yourself. With monochrome text, you might not notice a difference between 1200 by 1200 and 600 by 600.

Color ink-jets usually cost just a few hundred dollars more than monochrome ink-jets. These inexpensive color printers are excellent for adding splashes of color to borders, logos, and clip art. In addition, 720- by 360-dpi ink-jets are appearing in a market that was once limited to maximum resolutions of 360 by 360 dpi.

Keep in mind, however, that the resolutions reported by printer vendors actually translate into addressability. You might be able to address 720 by 360 dpi, but if your dots (similar to a monitor's dot pitch) overlap much, the *real* resolution (i.e., the sharpness of your output) is potentially quite different than what the reported resolution would lead you to assume.

Color laser printer vendors are now aiming their wares at the general-business market. Color laser printers can produce full-color output in pages per minute rather than in minutes per page, and their prices have dropped substantially during the past two years.

This month we look at eight 6- to 10-ppm monochrome lasers, 10 11- to 30-ppm monochrome lasers, seven color ink-jets, and four color lasers. All were released to the market on or after June 1, 1994.

How to use this guide

We used our standard suite of DOS, Windows, and Mac OS–based printer tests to choose winners in four categories: color ink-jets, 6- to 10-ppm lasers, 11- to 30-ppm lasers, and color laser printers. Using charts like the one shown here, we summarize test details about the winners and runners-up in each of these categories.

A printer's combined engine and processor speed when running our test files, measured in pages per minute. Higher numbers indicate faster performance.

A composite rating for performance, features, usability, and quality, based on a 10-point scale; higher numbers are better.

BEST OVERALL Kyocera Ecosys FS-3600A



This 18-ppm printer was the fastest of the 11- to 30-ppm laser printers, producing superior PCL and PostScript performance results in our stand-alone and network tests. Its standard features include a bidirectional parallel port, enhanced PCL5, and automatic switching between inputs. Instead of the usual toner cartridge, the FS-3600A uses a toner drum that is a permanent component of the printer; you replenish the toner drum about every 10,000 pages from a bumpable toner-supply container.

		OVERALL SCORE	PPM PCL	PPM POSTSCRIPT	PPM MAC	VENDOR'S PPM RATINGS	SCORES QUALITY	SCORES FEATURES	SCORES USABILITY	PRICE AS TESTED
BEST	Kyocera Ecosys FS-3600A	8.11	13.56	13.36	N/A	18	▲▲▲	▲▲▲	▲▲	$4482
RUNNER-UP	Dataproducts Typhoon 20	7.81	10.98	10.68	9.03	20	▲▲▲	▲▲▲▲	▲▲▲▲	$7255
RUNNER-UP	HP LaserJet 4MV	7.71	10.95	10.82	8.63	18	▲▲▲▲	▲▲▲	▲▲▲	$3549
RUNNER-UP	Lexmark Optra Rx	7.71	5.47	5.64	5.20	18	▲▲▲▲	▲▲▲	▲▲▲▲	$2896
RUNNER-UP	OMS 1680 Print System	7.61	10.59	9.95	9.12	18	▲▲▲▲	▲▲▲	▲▲▲	$4899

A vendor's rating for engine or print-head speed; does not include a printer's processing time.

The retail price of the printer as configured for our tests. This price may include optional memory (see the Roll Call on page 168).

PHOTOGRAPHY: STEVE BELKOWITZ © 1995

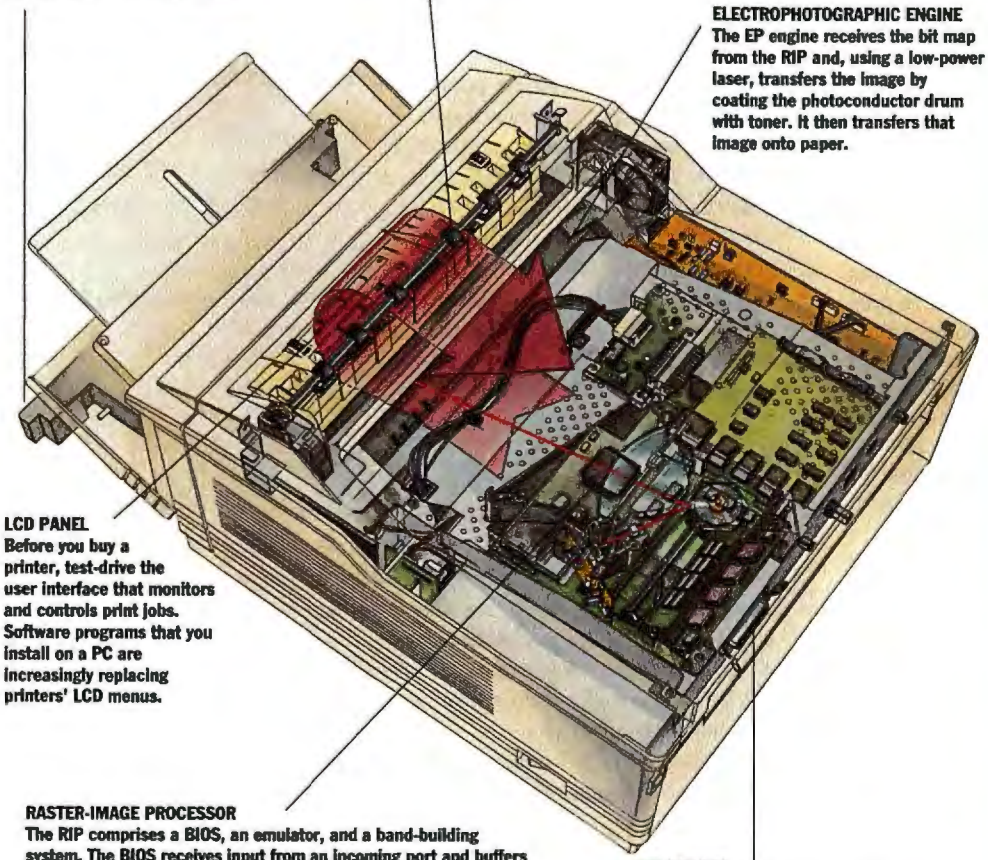
MEAN BUSINESS

The Impressive Parts

PAPERFEED MECHANISM
A roller picks a piece of paper from the input tray and passes it to an anti-skew, heavy-friction roller. From there, it passes an aligning roller, and then a metering roller. It then goes through the EP engine, where it gets the image impressed onto it. From there, it goes through to the fusing hot roller. Finally, it heads through rollers that escort the end product to the exit bin.

PAPER TRAYS
Think carefully of all the types of paper you might need your printer to handle. If capacity is important, check the Roll Call on page 168 for maximum paper-capacity ratings.

ELECTROPHOTOGRAPHIC ENGINE
The EP engine receives the bit map from the RIP and, using a low-power laser, transfers the image by coating the photoconductor drum with toner. It then transfers that image onto paper.



LCD PANEL
Before you buy a printer, test-drive the user interface that monitors and controls print jobs. Software programs that you install on a PC are increasingly replacing printers' LCD menus.

RASTER-IMAGE PROCESSOR
The RIP comprises a BIOS, an emulator, and a band-building system. The BIOS receives input from an incoming port and buffers that data, transmitting it at the highest transfer rate that it and the processor can sustain. The emulator scans the data and determines its PDL (page-description language), parses it, and then renders a full-page bit map. The band-building system quickly creates a series of bands, which it then hands off to the EP engine.

INTERFACES
The more interface options a printer has, the better. Parallel ports should be high-speed and bidirectional, with support for the IEEE 1284 standard. SCSI connectors should be SCSI-2, preferably fast and wide. For a network printer, look for fast Ethernet, LocalTalk, and/or Token Ring. You might need an SNMP-compliant interface, but be wary of anything proprietary. Good network printers can receive data from all ports simultaneously; look for "multiprotocol, multitasking" models.

11- to 30-PPM LASERS

Best Overall
Kyocera Ecosys FS-3600A

This 18-ppm printer was the clear winner in speed for both PCL and PostScript and as a NetWare print server. It also offers an ecologically sound ink-medium system.
PAGE 156

High-Quality
Lexmark Optra Rx

This easy-to-use, 1200-dpi printer produces crisp and clear text, graphics, and photographic images. It also boasts a monthly duty cycle of 40,000 pages.
PAGE 156

6- to 10-PPM LASERS

Best Overall
QMS 1060 Print System

This 10-ppm, 600-dpi printer offered the best PCL and Macintosh performance scores in the 6- to 10-ppm category, and it produced above-average output quality.
PAGE 160

Low-Cost
DEClaser 5100

The leader in 6- to 10-ppm lasers priced at under $2000, this 600-dpi printer offers good output quality and sophisticated printer-monitoring software.
PAGE 160

COLOR INK-JETS

Tektronix Phaser 140

This ink-jet led the category in output quality. The Phaser 140 ships with standard Adobe PostScript and parallel and LocalTalk interfaces; it offers an optional Ethernet interface as well.
PAGE 162

COLOR LASERS

Xerox 4900 Color Laser Printer

The Xerox 4900 produced the best color and monochrome quality in its class. It's rated at 12 ppm for monochrome output and at 3 ppm for color output.
PAGE 164

ILLUSTRATION: BRUCE SANDERS © 1995

ESSENTIAL FOR LARGE WORKGROUPS

11- TO 30-PPM LASERS

The 11- to 30-ppm laser-printer category targets workgroups in a networked environment. We tested the speed of the 10 printers in this group as stand-alone units and as print servers on a Novell NetWare 3.12 Ethernet network. Requirements for this category include an Ethernet interface, support for both PCL and PostScript, and a minimum of 6 MB of memory. The printers in this group share the following characteristics: manufacturer-rated speeds of between 12 and 20 ppm, minimum print resolutions of 600 by 600 dpi, the ability to be configured as a shared printer on a network, automatic switching between interfaces, auto-sensing between emulations, and monthly duty cycles that range from 10,000 to 50,000 pages.

The Kyocera Ecosys FS-3600A earned our best-overall rating, reflecting its superior performance in our PCL, PostScript, and network tests. The 18-ppm FS-3600A came in at just under 16 ppm in our text tests. Although it boasts a maximum resolution (i.e., addressability) of 600 by 1200 dpi, the FS-3600A has an output quality that, while good, received stiff competition from the other printers and so was rated only about average for the group. We like the FS-3600A's compact, 24-pound frame.

Priced at $4193, the unit Kyocera sent us included standard support for PCL5e and PostScript Level 1, as well as an optional Ethernet connection. Kyocera also provides LocalTalk and Token Ring interface options.

The more ponderous 75-pound Dataproducts Typhoon 20 finished second in the best-overall category. The Typhoon 20 delivers a strong mix of performance, quality, and features. The 20-ppm Typhoon 20 (Dataproducts also offers a 30-ppm model, the Typhoon 30, and a 60-ppm model, the Typhoon 60) has a maximum print resolution of 800 by 800 dpi. But its paper-handling features set it apart: The Typhoon 20 ships standard with three paper trays, can output pages face-up or face-down, supports a maximum input capacity of 850 sheets, and has a 50,000-page monthly duty cycle.

VIRTUAL PRINTERS

At one time or another, you've probably sent a file to print and waited around while nothing happened. That's called virtually printing. But don't be mistaken: Dataproducts' Virtual Printing Technology, or VPT for short, is something quite different. VPT adds network smarts to printers by acknowledging and receiving up to 64 different printer configurations concurrently, each with its own network protocol, operating system, printing language, default resolution, paper size, font, and orientation. So, instead of stopping stone-cold when it receives a file it can't print, a printer with VPT rejects that file and goes about printing the files that it can.

Dataproducts designed VPT to work on any network printer, although different printers might support a different range of VPT features. When a VPT-enhanced printer receives a document addressed to one of its virtual printers, it adjusts its configuration accordingly. For example, one user's virtual printer might translate to an Apple EtherTalk, System 7.0, PageMaker file in 800- by 800-dpi resolution using PostScript Level 2, 12-point Gothic type, on letter-size paper, in landscape orientation. At the same time, another client on the network could click on the Print command and automatically evoke an entirely different setup.

VPT follows the client/server model: The VPT-equipped printer is the server, and the computers that send it jobs are clients, each appearing as a separate network node. By default, the NOS (network operating system) handles queuing and prioritization; alternatively, you could use middle-management systems to provide print-queuing and spooling services.

Dataproducts' VPT associates all of a printer's user-configurable parameters as 64 virtual ports, thus performing an elaborate form of emulation switching. VPT can also give you access to printer features that aren't selectable in your host-resident drivers.

And while VPT gives a network user the flexibility to configure a network printer as if it were his or her own personal printer, a network administrator can use VPT as an SNMP management utility that forces people to access printers in certain ways. For example, an administrator can set up a virtual printer so that only certain network users have access to certain trays. VPT also includes resource accounting, which enables an administrator to discern who is printing what, how many copies, and how often.

Dataproducts' VPT concurently supports such protocols as TCP/IP, Apple EtherTalk, Novell IPX, Token Ring, and Digital's LAT (Ethernet only). It supports more than 20 operating systems, including VMS, NetWare, LAN Manager, Windows, Windows NT, and 12 versions of Unix.

VPT 3.0 SUPPORTS:

- LocalTalk
- Bidirectional IEEE 1284 (parallel)
- RS-232/RS-422 (serial)
- 10Base-T/10Base-2 (Ethernet)
  - DEC LAT services
  - IPX services (Novell NetWare)
  - EtherTalk
  - TCP/IP services
- UTP/STP Token Ring
  - IPX
  - EtherTalk
  - TCP/IP

An ecologically sound, solid performer

BEST OVERALL — Kyocera Ecosys FS-3600A



This 18-ppm printer was the fastest of the 11- to 30-ppm laser printers, producing superior PCL and PostScript performance results in our stand-alone and network tests. Its standard features include a bidirectional parallel port, enhanced PCL5, and automatic switching between inputs. Instead of the usual toner cartridge, the FS-3600A uses a toner drum that is a permanent component of the printer; you replenish the toner drum about every 10,000 pages from a burnable toner-supply container.

		OVERALL SCORE	PPM PCL	PPM POSTSCRIPT	PPM MAC	MFR.'S PPM RATING	SCORES QUALITY	SCORES FEATURES	SCORES USABILITY	PRICE AS TESTED
BEST	Kyocera Ecosys FS-3600A	8.11	13.55	13.36	N/A	18	▲▲▲	▲▲▲	▲▲	$4482
RUNNER-UP	Dataproducts Typhoon 20	7.81	10.98	10.58	9.03	20	▲▲▲	▲▲▲▲	▲▲▲▲	$7255
RUNNER-UP	HP LasterJet 4MV	7.71	10.95	10.82	8.63	16	▲▲▲▲	▲▲▲	▲▲▲	$3549
RUNNER-UP	Lexmark Optra Rx	7.71	5.47	5.64	5.20	16	▲▲▲▲	▲▲▲	▲▲▲▲	$2898
RUNNER-UP	QMS 1660 Print System	7.61	10.59	9.95	9.12	16	▲▲▲▲	▲▲▲	▲▲▲	$4899



In addition, Dataproducts' Virtual Printer Technology allows up to 64 different printer configurations simultaneously on a heterogeneous network (see the text box "Virtual Printers"). In short, it would be a crime not to connect the Typhoon 20 to a network. The unit's only big drawback is its hefty $7255 price tag.

Following close behind the Typhoon 20 is Hewlett-Packard's LaserJet 4MV. Reasonably priced at $3549, the 4MV can print 16 ppm at 600 by 600 dpi, has a maximum resolution of 600 by 600 dpi, and supports PCL5e, HPGL/2, and Adobe PostScript Level 2. The 4MV also comes with HP's multiprotocol JetDirect card for LocalTalk and Ethernet, plus a user-configurable I/O buffer. The 4MV offers a monthly duty cycle of 35,000 pages and a maximum input capacity of 850 pages. Options include a 42-MB internal hard drive, to give you access to Adobe Type 1 fonts, and a JetDirect card for Token Ring connectivity.

Lexmark's 1200- by 1200-dpi Optra Rx produced the highest-quality output, though not at spectacular speeds: It prints 16 ppm at 300 by 300 dpi, but only 8 ppm at 1200 by 1200 dpi. But it compensates for this lackluster performance with truly crisp line drawing, readable text in sizes as small as 1.5 points, and near-photographic-quality gray-scale images. Its bidirectional print utility allows local and remote printer control. An optional MarkNet adapter allows you to connect to 18 different NOSes (network operating systems) simultaneously.



Selling for $2298, the DEClaser 3500 is a good buy. Like many Digital Equipment products, its construction is solid, and the 3500 comes with a particularly good setup guide. Its PCL driver lets you change the image-control setting from either the imaging-mode or manual-select setting to the smart-laser setting. This setting automatically selects an appropriate image-control setting for you.

If you are searching for a workgroup printer priced under $2500, you should consider these 600- by 600-dpi laser printers: the Apple LaserWriter 16/600 PS ($2429), the Canon LBP-1260 ($2298), and the Texas Instruments microLaser PowerPro ($1639). The LaserWriter stands out with 8 MB of standard RAM and a 17-ppm engine rating.

Reliability is another important consideration when choosing a printer. Although most of the units in this review come with one-year warranties on parts and labor, Canon's LBP-1260 includes a two-year warranty on parts and labor, and Lexmark's Optra Rx and Apple's LaserWriter 16/600 PS both include one-year warranties on parts and labor, as well as free freight to and from the repair center.

A new printer that missed our testing deadline is the QMS 1660E Print System. While the current 1660 configuration ships standard with LocalTalk and offers Ethernet as an option, the 1660E ships standard with Ethernet and offers LocalTalk as an option.

For the best-looking output...

HIGH-QUALITY — Lexmark Optra Rx



This 16-ppm printer, which supports 300, 600, and 1200 dpi, produced the best-looking output in this category. Lexmark designed the Optra Rx for single-user desktops and connected workgroups with moderate printing volumes. Its standard features include enhanced PCL5, PostScript Levels 1 and 2, and auto-sensing between emulations and auto-switching between inputs. The Optra Rx has an intuitive control panel and, at 40,000 pages per month, the second-highest duty cycle of all the printers we tested. Options include duplex printing and a 40-MB hard disk.

		OVERALL SCORE	PPM PCL	PPM POSTSCRIPT	PPM MAC	MFR.'S PPM RATING	SCORES QUALITY	SCORES FEATURES	SCORES USABILITY	PRICE AS TESTED
BEST	Lexmark Optra Rx	7.71	5.47	5.64	5.20	16	▲▲▲▲	▲▲▲	▲▲▲▲	$2898
RUNNER-UP	QMS 1660 Print System	7.61	10.59	9.95	9.12	16	▲▲▲▲	▲▲▲	▲▲▲	$4899
RUNNER-UP	Canon LBP-1260	6.78	8.14	6.37	N/A	12	▲▲▲▲	▲▲▲	▲▲▲▲	$2298
RUNNER-UP	Apple LaserWriter 16/600 PS	7.35	10.35	10.04	9.00	17	▲▲▲▲	▲▲▲	▲▲▲	$2429
RUNNER-UP	Xante Accel-a-Writer 8200	7.23	8.66	8.42	7.41	16	▲▲▲▲	▲▲▲▲	▲▲▲	$7990

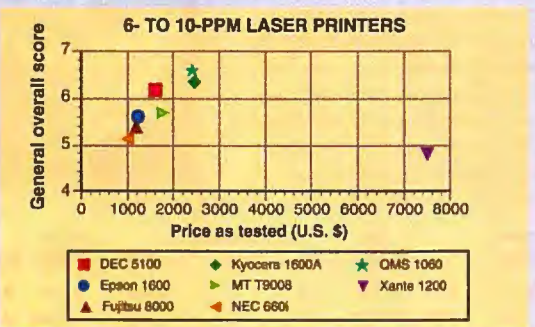
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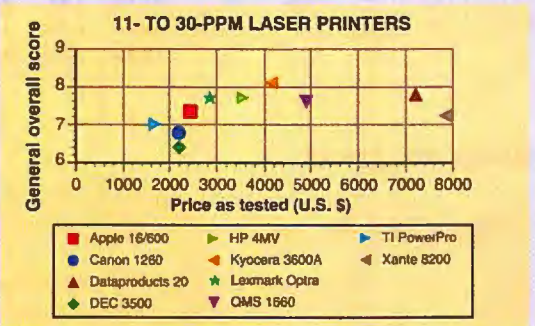
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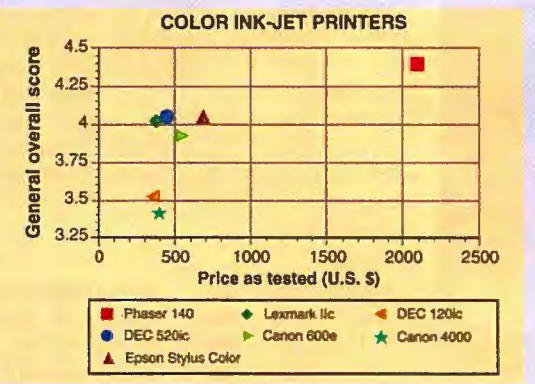
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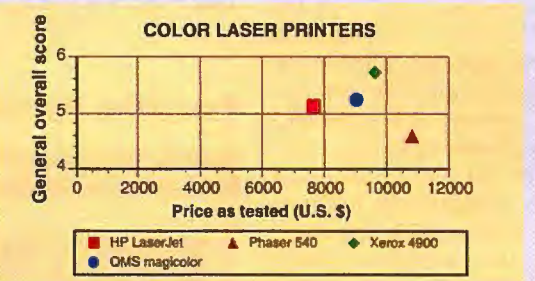
Price vs. Performance and Features

These charts depict the ratios of the general overall scores (a weighted combination of performance, quality, features, and usability) to the prices for the printers as tested. See the Roll Call (on pages 168 to 171) to discern the as-tested configurations and to look for the specific features you need.





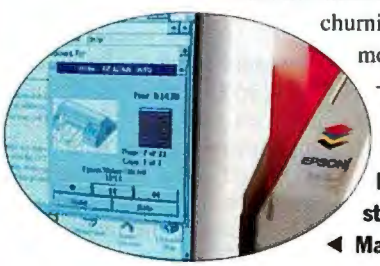




HONORABLE MENTIONS

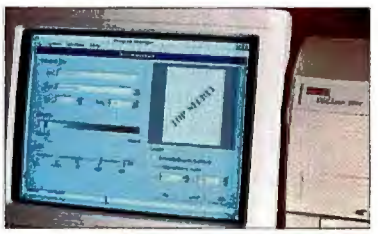
The Dataproducts Typhoon 20 offers multiple paper-handling options. The Typhoon we tested has three 250-sheet paper trays and supports paper sizes from letter to B5. It also has a manual-feed tray for postcards, heavy paper stock, and adhesive labels. An optional multimedia feeder inserts stacks of envelopes—which, in most printers, must be inserted one at a time—and a face-up exit tray spares transparencies from being curled by the printer's rollers. The 20-ppm laser printer, which supports resolutions of up to 800 dpi in PostScript mode, has an intuitive control panel and is capable of churning out 50,000 pages per month.





Epson's Stylus Color Ink Jet Printer lets you know where you stand. The Epson Spool Manager utility icon appears on-screen when you send data to the printer. If you double-click on this icon, a dialog box appears, informing you of the status of the print job, including details of the current page. Nested menus let you hold print jobs, reorder them for later printing, or delete them. Another nice feature is that you don't have to swap color and monochrome cartridges; both are installed at all times.

The DEClaser 3500 is one of the few printers around that let you edit *watermarks*, the superimposed text controlled by the driver on your final output. If you're not in love with your confidential or draft watermark, you can open the DEClaser 3500's printer-setup utility and change the text, font, size, angle, percentage of gray, and *x*,*y* position of a watermark. This 12-ppm workgroup laser printer provides many ways to improve the quality of output; its SmartLaser imaging feature analyzes all your print jobs and chooses the best of three imaging modes (spreadsheets and tables, presentations, and entire page as graphic) for the job.





At Lexmark, we don't limit top-of-the-line features to our top-of-the-line printers.

The new Optra™ family is the first full line of network-ready, desktop laser printers capable of true 1200 x 1200 dpi* printing. Each Optra laser printer, from the extremely affordable 12 ppm Optra R to the extremely powerful 16 ppm Optra Lxi, delivers four times the sharpness of ordinary 600 dpi printers.

yes
It runs with NetWare®

No matter which option you choose, our breakthrough MarkVision™ printer utility is standard. Users and LAN managers can control and configure every Optra on the network, and monitor job statistics, right from Windows™ or Macintosh workstations.

PostScript™ Level 2 and enhanced PCL® 5 emulations are also standard. Which means that every Optra prints incredibly sharp graphics and beautiful, crisp text from virtually any of your applications.

All this value and innovation from Lexmark, a former division of IBM. For more information, call us at **1 800 891-0399, ext. 231.**

Thanks to the new Optra family, you can choose the best printer, rather than the best compromise.

LEXMARK™

ADVANCING THE ART OF PRINTING

*1200 dpi requires additional memory for complex files. Lexmark products are manufactured under the ISO 9002 approved quality process. The Energy Star emblem does not represent EPA endorsement of any product or service. Lexmark, Optra and MarkVision are trademarks of Lexmark International, Inc. NetWare is a registered trademark of Novell, Inc. Windows is a trademark of Microsoft Corporation. Macintosh is a registered trademark of Apple Computer, Inc. PostScript is a trademark of Adobe Systems Incorporated, which may be registered in certain jurisdictions. PCL is a registered trademark of Hewlett-Packard Company. © 1995 Lexmark International, Inc.

SOLID, MIDRANGE PRINTERS

6- TO 10-PPM LASERS

We tested eight 6- to 10-ppm laser printers, which are well suited for stand-alone use and for small workgroups. These units print text and graphics in highly acceptable quality—better than just adequate.

All but Fujitsu's 300- by 300-dpi PrintPartner 8000, Kyocera's 600- by 1200-dpi Ecosys FS-1600A, and Xante's 1200 by 1200 LaserPress 1200 offer maximum print resolutions of 600 by 600 dpi. The LaserPress 1200 outputs near-typeset-quality text. All but one, the inexpensive NEC SuperScript 660i, offer either a standard or optional network/LocalTalk interface. They all come with PCL5 and offer standard or optional PostScript. We requested that vendors ship their 6- to 10-ppm laser printers to us with a minimum of 4 MB of RAM.

The best-overall rating for this group went to QMS's 1060 Print System. The 1060, with a manufacturer's rated speed of 10 ppm, produced the fastest PCL and Mac performance results and finished second in our PostScript performance tests. In the PCL raw-text test, the QMS 1060 printed approximately 8.7 ppm at 300 dpi. This 600- by 600-dpi unit also offers above-average output quality.

With a $2399 price tag, the 1060 ships with PCL5, PostScript Levels 1 and 2, and SCSI and LocalTalk connections. Ethernet and Token Ring interfaces are optional. It offers a monthly duty cycle of 10,000 pages and a maximum input capacity of 1150 pages.

The Kyocera Ecosys FS-1600A placed second overall. The FS-1600A is a 10-ppm printer with a maximum true resolution of 600 by 1200; it delivered the fastest PostScript score in this category and the second-fastest PCL scores. The unit we tested had a list price of $2464.

The FS-1600A ships with PCL5e standard and provides PostScript Level 1 as a $289 option. LocalTalk, Token Ring, and Ethernet interfaces are also optional. The FS-1600A offers a monthly duty cycle of 25,000 pages, which is the highest in this group.

The printer's ecologically sound toner contains ceramic particles that continuously clean and polish the drum; Kyocera claims that, because you never need to purchase actual cartridges, the resulting cost per page is an outstandingly low 7 cents. A long-life fuse in the processor reduces power consumption, admitting the FS-1600A into the EPA Energy Star program.

MULTIFUNCTIONAL PERIPHERALS

If you're short on floor space and need a printer, a fax machine, a copier, and a scanner, then you're a likely candidate for the Swiss Army knife of office machines: an MFP (multifunctional peripheral). Often called *hydras*, these multiheaded printers are growing in demand in the SOHO (small office/home office) market—or anywhere you need a single peripheral that can do it all. MFPs represent the inevitable evolution of the SOHO printer market—the convergence of office peripherals—because scanners, copiers, printers, and fax machines all use similar paper-marking engines.



The Toshiba TF505 is a small printer that also has the ability to handle scans, copies, and faxes.

During the early 1990s, most MFP products were fast, expensive machines aimed at the high end of the market, but in 1994, one-stop peripherals with affordable prices emerged for the SOHO market. BIS Strategic Decisions analyst Barry Tepper reports that you can purchase Hewlett-Packard's top-selling OfficeJet for $795, while a plain-paper fax machine, an ink-jet printer, and a personal copier cost more than $1000 if you purchase them all separately.

Notable printer vendors, such as Canon USA, Okidata, QMS, Ricoh, Toshiba, and Xerox, offer hydras of varying stripes. The HP OfficeJet is a monochrome DeskJet ink-jet printer with a 9600-bps modem; it can also scan and fax documents. Toshiba's TF505, a $2399 4-ppm laser printer, also serves as a scanner, a plain-paper fax machine, and a copier. To print documents on the TF505 from a PC, you must install Toshiba's Windows-based ImageVision III Print Manager and connect the TF505 to a host system with a bidirectional parallel cable.

To push the MFP market forward and to obviate the need for proprietary interfaces, the MFPA (Multifunction Printer Association) is promoting support for its MFPI (Multifunction Peripheral Interface). Completed as an interim standard in February, the MFPI standard provides a nonproprietary API for controlling MFPs. The proposed international standard is tailored to be compatible with Microsoft's proprietary MAW (Microsoft At Work) standard and is based on a similar concept, but Microsoft has yet to embrace MFPI. It is also questionable whether Microsoft is actively supporting MAW anymore. Novell reports that its set of technologies called NEST (Novell Embedded Systems Technology), for controlling peripherals on a NetWare LAN, will be compatible with MFPI.

BYTE BEST — 6- TO 10-PPM LASER PRINTERS

The DEClaser 5100 distinguished itself with the third-highest overall rating, the top rating in the under-$2000 price range, and the best-overall quality score, thanks in part to an image-enhancement feature for PostScript. This 600- by 600-dpi, 8-ppm printer is a bargain at $1599, and it comes standard with an envelope feeder, LocalTalk, Enhanced PCL5, and Adobe PostScript Level 2, including 115 scalable fonts. Font expansion is available through PCMCIA slots or via an optional hard disk. The printer has a monthly duty cycle of 20,000 pages and a maximum input capacity of 850 pages in three trays.

The Xante LaserPress 1200 was the only 1200- by 1200-dpi printer in this group. It produces crisp lines and text and beautiful gray-scale images; however, the lack of a print-density-control feature caused it to suffer in our white-on-black quality test, a test with which other printers had some degree of difficulty as well.



Designed to provide output for anything ranging from basic office draft documents to near-typeset-quality images, the LaserPress 1200 was the most fully featured product in the 6- to 10-ppm range. Rated at 8 ppm, its base configuration includes 24 MB of RAM (it can hold 64 MB), a multipurpose sheet feeder, PCL5, PostScript and HPGL/7475A drivers, and LocalTalk, SCSI-1, and Ethernet connections.

If you're looking for a personal, stand-alone printer, the low-priced NEC SuperScript 660i might fit the bill. This 6-ppm, 600- by 600-dpi printer provides only one interface—a bidirectional parallel port—but the 2-MB base model costs just $799. The unit we tested had 6 MB. Because NEC doesn't sell memory for its printers, the $999 price quoted for the 6-MB model reflects NEC's estimated street price for the additional RAM.

The SuperScript 660i ships with PCL5e and GDI emulations, and there's a PostScript Level 2 option available for $99. In GDI mode, you can add one of three colors to your document, but to do so you must purchase a color cartridge.

Other printers in this category selling for under $2000 include the Epson ActionLaser 1600 ($1199 with 4 MB of RAM), the Fujitsu PrintPartner 8000 ($1186 with 5 MB), and the Mannesmann Tally T9008 Laser ($1768 with 6 MB). The 6-ppm, 600- by 600-dpi ActionLaser 1600 has a bidirectional parallel interface and PCL5e. LocalTalk, Ethernet, and PostScript Level 2 are optional. The PrintPartner 8000 is a 16-pound, 300- by 300-dpi, 8-ppm printer that ships standard with PCL5 and offers LocalTalk, Ethernet, and PostScript Level 1 as options. The T9008 Laser is an 8-ppm, 600-dpi, PCL5e unit that provides optional LocalTalk, Ethernet, Token Ring, and PostScript Level 2 support.

A new printer in this group that missed our testing deadline is the QMS 1060E Print System. Announced in January, it costs the same as the QMS 1060 that we tested: $2399. The 1060 ships standard with LocalTalk and offers an Ethernet interface as an option, whereas the 1060E ships standard with Ethernet and offers LocalTalk as an option.

For modest workgroups...

BEST OVERALL — QMS 1060 Print System





This 10-ppm, 600-dpi printer offers four resident emulations: PCL5, PostScript Levels 1 and 2, HPGL, and Lineprinter, with auto-sensing between emulations. You can print on a variety of paper sizes with the 1060, including letter, legal, executive, A4, B5-ISO, envelopes, and postcards. The 1060 comes standard with simultaneously active parallel, serial, and LocalTalk interfaces, plus two optional network interfaces. Also optional are PCMCIA slots for font cards and hard disk support. The 1060 supports up to 64 MB of RAM, provides a base tray capacity of 500 sheets (the highest of this group), and can hold three input trays.

		OVERALL SCORE	PPM PCL	PPM POSTSCRIPT	PPM MAC	MFR.'S PPM RATING	SCORES QUALITY	SCORES FEATURES	SCORES USABILITY	PRICE AS TESTED
BEST	QMS 1060 Print System	6.58	7.92	7.34	6.39	10	▲▲▲▲	▲▲▲	▲▲▲	$2399
RUNNER-UP	Kyocera Ecosys FS-1600A	6.36	7.81	7.76	5.98	10	▲▲▲	▲▲▲	▲▲▲	$2464
RUNNER-UP	Digital DEClaser 5100	6.25	6.05	5.56	5.36	8	▲▲▲▲	▲▲▲	▲▲▲▲	$1599
RUNNER-UP	Mannesmann Tally T9008 Laser	5.70	6.21	N/A	N/A	8	▲▲▲	▲▲▲	▲▲▲	$1768
RUNNER-UP	Epson ActionLaser 1600	5.62	5.37	N/A	N/A	6	▲▲▲▲	▲▲▲	▲▲▲▲	$1199

For budgets under $2000...

LOW-COST — DEClaser 5100



The DEClaser 5100, priced at $1599 as tested, was the overall winner among the 6- to 10-ppm lasers in the under-$2000 range. Digital designed this printer with small workgroups in mind. It supports Adobe PostScript Level 2 and Enhanced PCL5; auto-sensing between emulations; simultaneous support of serial, parallel, and LocalTalk ports and an optional Ethernet port; font expansion through PCMCIA slots; and an optional hard drive for storing additional fonts. The DEClaser 5100 also earned the highest quality rating in the 6- to 10-ppm laser category. You can configure the unit's bidirectional driver to alert you of the printer's status with either visual effects or sound effects, including a male or female voice.

		OVERALL SCORE	PPM PCL	PPM POSTSCRIPT	PPM MAC	MFR.'S PPM RATING	SCORES QUALITY	SCORES FEATURES	SCORES USABILITY	PRICE AS TESTED
BEST	Digital DEClaser 5100	6.25	6.05	5.56	5.36	8	▲▲▲▲	▲▲▲	▲▲▲▲	$1599
RUNNER-UP	Mannesmann Tally T9008 Laser	5.70	6.21	N/A	N/A	8	▲▲▲	▲▲▲	▲▲▲	$1768
RUNNER-UP	Epson ActionLaser 1600	5.62	5.37	N/A	N/A	6	▲▲▲▲	▲▲▲	▲▲▲▲	$1199
RUNNER-UP	Fujitsu PrintPartner 8000	5.41	6.37	N/A	N/A	8	▲▲▲	▲▲	▲▲▲	$1186
RUNNER-UP	NEC SuperScript 660i	5.15	4.73	N/A	N/A	6	▲▲▲	▲▲	▲▲▲	$999

N/A = not applicable.

KEY

Ratings from 1 to 4:
▲ is the lowest;
▲▲▲▲ is the highest.

Color Ink-Jets

Unless you really need the quality of a color laser printer, why not cut your expenses with one of the seven color ink-jets reviewed here? The idea of buying a color ink-jet for only $100 or so more than the price of a monochrome ink-jet printer is indisputably appealing.

Most of these color ink-jets are considerably smaller, less expensive, and slower than the lasers we tested for this report, but they provide better quality and quieter operation than dot-matrix printers. Their main attraction is that they offer color at reasonable prices. We tested seven color ink-jets, which range in price from $355 to just over $2000.

We awarded the best-overall color ink-jet moniker to Tektronix's Phaser 140. The 140 is the only PostScript printer—and the only one to offer an optional Ethernet interface—in this category. Its as-tested price of $2091 makes it the most expensive of the color ink-jets, but if you're looking for quality, it's worth it. With a resolution of 360 by 360 dpi, the Phaser 140 takes its time and produces color output comparable to—but for thousands of dollars less than—the least expensive color laser we tested. Its monochrome quality was also comparable to that of most of the monochrome laser printers we tested.



The easy accessibility of the Phaser 140's ink cartridges (left), along with its high-quality output (above), gives the 140 our top rating in its class.

The Phaser 140 can print on plain, coated, or glossy paper and on transparencies (we used the glossy paper provided by Tektronix). You can print on legal-size paper by upgrading the printer from its standard 8-MB configuration to a 12-MB one. The Phaser 140's trade-off for quality is speed—or lack thereof. In fact, it was one of the slowest color ink-jets we tested.

Epson's Stylus Color Ink Jet and Digital's colorwriter 520ic tied for second place. At 720 by 720 dpi, the Epson Stylus has the highest addressability in this category. Its second-place status was due not just to its outstanding quality but also to its all-around solid showing in our quality, features, and usability analyses. The Stylus printer software offers many options for optimizing the quality of output and for monitoring print jobs. You can print on plain paper at 360 dpi on the Stylus; special coated paper is required for 720-dpi resolution.

The Digital colorwriter 520ic attained the fastest performance results in the group; it has a 5-ppm rating for monochrome output and a 0.3-ppm rating for color output. An RS-232 port is optional. The colorwriter 520ic supports the HP DeskJet 500/500C/550C emulation and up to two output trays for a maximum paper capacity of 300 sheets (twice as many as its closest competitor in the paper-capacity category).

At $355, Digital's lower-end colorwriter 120ic is the least expensive color ink-jet we tested, and it posted the second-fastest performance and the best usability scores. Its monochrome speed is rated at 2 ppm, and its color is rated at 0.3 ppm. It has a relatively low maximum input capacity of 70 pages and offers parallel input only. Weighing in at 8.3 pounds and sporting a small footprint (about 14 by 14 by 11 inches), the colorwriter 120ic is a good candidate for road trips.

The fourth-ranked Lexmark ExecJet IIc is a 300- by 300-dpi printer priced at $379 with a monochrome speed rating of 3 ppm. Its color output is rated at 2.5 to 7 minutes per page, *not* pages per minute.

The two Canon ink-jets we tested were easy to operate. They both come with a laminated quick-start guide for easy setup and extensive on-line Windows-based help that includes pointers for setup, use, maintenance, and troubleshooting. The BJC-600e offers the second-best quality rating and has a price of $549. It has a 3-ppm rating for monochrome output and a 1-ppm rating for color output. The $399 BJC-4000 offers a 5-ppm monochrome rating and a 0.8-ppm rating for color.

Apple's Color Stylewriter 2400 was submitted to us for testing, but we weren't able to compare it to the others in this report because it was the sole Macintosh-only printer in our roundup. However, we can vouch for Apple's reputation for making solid and reliable printers.

BEST OVERALL—TEKTRONIX PHASER 140

If you're looking for excellent monochrome and color quality from an ink-jet, the Phaser 140 provides it. This 360- by 360-dpi color ink-jet has built-in Adobe PostScript Level 1 and 2 support, comes with parallel and LocalTalk ports, and offers Ethernet as an option. Designed for workgroups, its networking ports work simultaneously. The Phaser 140 comes standard with 17 resident fonts and 8 MB of RAM. It does high-quality printing on plain, coated, and glossy paper and transparencies, and, if you add a 4-MB RAM upgrade, on legal paper as well. It's a bit slow, but quality takes time.

	OVERALL SCORE	PPM PCL	PPM POSTSCRIPT	PPM MAC	MFR.'S PPM RATING	SCORES QUALITY	SCORES FEATURES	SCORES USABILITY	PRICE AS TESTED
Tektronix Phaser 140	4.31	N/A	1.11	N/A	2	▲▲▲▲	▲▲▲	▲▲▲▲	$2091
Digital colorwriter 520ic	4.06	4.13	N/A	N/A	5	▲▲	▲▲	▲▲▲▲	$449
Epson Stylus Color Ink Jet	4.06	2.47	N/A	N/A	2–3	▲▲▲	▲▲▲	▲▲▲▲	$699
Lexmark ExecJet IIc	4.03	2.69	N/A	N/A	3	▲▲▲	▲▲	▲▲▲	$379

Key: Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest. N/A = not applicable.



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Color Lasers

Color laser printers are targeted toward business workgroups that require fast, professional output that contains some spot color for logos, charts, and business graphics. Photo-realistic dye-sublimation printers and thermal-wax-transfer devices are still more appropriate for advertising, sales, and marketing departments; artists; and professional photographers. A color laser printer can easily set you back five figures, but recent introductions of some lower-cost models aimed at the general-business market are increasing the volume for manufacturers and broadening their appeal.

We tested four color lasers: the HP Color LaserJet, the QMS magicolor Laser Printer, the Tektronix Phaser 540, and the Xerox 4900 Color Laser Printer. All are capable of monochrome and four-color output; support both PCL5 and PostScript; offer LocalTalk, Ethernet, and Token Ring interfaces; and support auto-switching between inputs and auto-sensing between emulations. All four printers can produce high-quality color documents on regular copier-type paper.

The Xerox 4900 produced the highest-quality output of the four. This 1200- by 300-dpi printer was able to produce saturated colors and fine dithering patterns with no bleeding in our color-quality tests. Our Colortron colorimeter–based test results indicate that the Xerox 4900 produces the most consistent colors.

Priced at $9444, the 4900 has a speed rating of 12 ppm for monochrome output and 3 ppm for full color. The unit also offers an optional "media server," a 3½-inch floppy drive that allows users who are not on a network to print PostScript, PCL, or EPS (Encapsulated PostScript) files directly from a floppy disk.

Our first runner-up in this group was the QMS magicolor Laser Printer. The model that we tested came with 28 MB of RAM to support its print resolution of 600 by 600 dpi; the same model configured with 12 MB of RAM can supply a print resolution of only 600 by 300 dpi. The $8999 QMS magicolor has a monochrome rating of 8 ppm and a color rating of 2 ppm. Parallel, serial, SCSI, and LocalTalk inputs are standard; Ethernet and Token Ring inputs, plus PostScript and PCL5, are optional.

HP's Color LaserJet was the fastest performer of the group. Rated at 10 ppm for monochrome output and 2 ppm for color, the $7604 Color LaserJet was also the least expensive color laser printer. Its monochrome-output quality was basically equivalent to that of a monochrome laser, except for its not-too-impressive gray-scale images. Its color-test pages showed rough dithering patterns. The Color LaserJet comes with a bidirectional parallel port and an MIO (modular I/O) slot. Optional inputs include serial, LocalTalk, Ethernet, and Token Ring. HP's Enhanced PCL5 with color is standard, and PostScript Level 2 is a $799 option.



The Xerox 4900, showing its color toner cartridges and internal floppy drive.

Tektronix's Phaser 540 produced color quality that was second only to that of the Xerox 4900. The Phaser 540 produced brilliant colors and fine dithering patterns on all our color-test pages. It also produced the widest range of colors. At $10,785, the Phaser 540 is the most expensive color laser printer we tested. The Phaser 540 has a maximum print resolution of 600 by 600 dpi and is rated at 14 ppm for monochrome output and 3½ ppm for color. It also offers an optional flatbed color photocopier.

These color laser printers are large: All fall into the 85- to 100-pound range. Expect to take a couple of hours for setup time, and be sure to follow the directions carefully. Pay special attention to the toner installation to avoid spills and future print-quality problems. A service technician set up the QMS magicolor for us, in compliance with the manufacturer's standard recommendations.

There's always one in every crowd: QMS's magicolor Plus Laser Printer missed our deadline for testing for inclusion in this report. Announced in January, this 600- by 600-dpi color laser printer has an entirely different printer engine than the QMS magicolor unit that we tested for this review, and it has a 3-ppm color-output rating and a 12-ppm rating for monochrome output. If you're really curious about this particular model, we suggest that you contact a dealer for performance specifications and check out its features yourself.

BEST OVERALL—XEROX 4900 COLOR LASER PRINTER

The Xerox 4900 provides four-color printing at speeds of up to 3 ppm and monochrome output at rates up to 12 ppm. It ships standard with Adobe PostScript Level 1 and 2 and PCL5 support; it has a maximum resolution of 1200 by 300 dpi. Serial, parallel, and LocalTalk interfaces can all be simultaneously active, with auto-sensing and auto-switching both standard. Ethernet and Token Ring interfaces are options.

	OVERALL SCORE	PPM PCL	PPM POSTSCRIPT	PPM MAC	MFR.'S PPM RATING	SCORES QUALITY	SCORES FEATURES	SCORES USABILITY	PRICE AS TESTED
Xerox 4900 Color Laser Printer	5.73	4.34	5.02	3.47	12	▲▲▲▲	▲▲▲	▲▲▲	$9444
QMS magicolor Laser Printer	5.23	N/A	3.93	3.68	8	▲▲▲	▲▲▲	▲▲▲	$8999
HP Color LaserJet	5.12	5.69	5.31	5.07	10	▲▲▲	▲▲	▲▲▲	$7604
Tektronix Phaser 540	4.58	N/A	2.53	N/A	14	▲▲▲	▲▲▲	▲▲▲	$10,785

Key: Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest. N/A = not applicable.

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How We Tested

Our test suite enables us to evaluate a printer's performance (i.e., speed), quality of printed output (with separate tests for monochrome and color), usability, and features. We test and score each of these elements separately, and then we compute the overall scores by assigning a weight to each element. We assign weights as follows: 45 percent for performance, 30 percent for quality, 15 percent for features, and 10 percent for usability.

We used a Compaq Deskpro 66M loaded with MS-DOS 6.2 and Windows 3.1 for the PC platform. We connected printers that arrived with Macintosh ports to a Quadra 640AV running System 7.1. We used the printer drivers that vendors either supplied or recommended, and we disabled print servers, spoolers, and buffers during performance testing.

PERFORMANCE

NSTL's performance tests measure the speed at which a printer can produce six different elements: dense text, sparse text, bit-mapped images, monochrome graphics, color graphics, and a minimum of two fonts. We test in three different ways for each platform: in the lowest and highest PCL resolutions (except for the Mac platform) and in the highest-resolution PostScript that each printer supports. The three platforms we tested this month were DOS/Windows, Macintosh, and a Novell NetWare 3.12 Ethernet environment.

We do a minimum of two test runs; if the results from two runs are not consistent, we perform a third run. If questions arise, we work with the manufacturer-designated technical-support person until we're confident the printer is set up correctly and is operating normally.

Text tests. The dense-text test requires printing a 2-KB file of ASCII text with little white space. Performance in this test correlates to raw speed, since there are no fonts or graphics for the printer to interpret. A second test document, designed to simulate the printing of invoices and forms, consists of ASCII text blocks broken up by interspersed areas of white space.

Graphics tests. The graphics tests use bit-mapped images to simulate documents with custom fonts and screen shots. These tests help us determine how efficiently each printer communicates with a computer. One test measures a printer's ability to draw complex lines and filled areas. A second test concentrates on producing curves and gray scales.

Font test. We use the font test to measure the speed of a printer's processor. The test requires printers to create Times (serif) and Helvetica (sans serif) fonts in regular and boldface in 30 different point sizes.

QUALITY, USABILITY, AND FEATURES

We judge the printers for monochrome-output quality on a series of pages that include a photographic image, text in a wide range of sizes, and a series of horizontal and vertical lines. For color printers, we add two additional pages: We judge one using objective criteria, such as the output's range of hues and the absence of smearing on fine lines. We judge the second page, which contains text and complex graphics, subjectively.

This month we've introduced tests that let us objectively measure the consistency and range of printed colors (see the text box "Measuring Color"). We used these new color tests only on the four color laser printers.

We compute usability scores based on such aspects as the ease of installing the ink media, the intuitiveness of the control panel, the ease of driver installation, and the clarity and usefulness of the provided manuals.

To arrive at the features score, we gather extensive information from vendors using a features questionnaire, verify these responses, and then compute a score using our weighting system. We assign weights for individual features based on their importance and their utility to the targeted market.

MEASURING COLOR



The Colortron colorimeter, from Light Source Computer Images.

We're using a new test to measure the range and consistency of colors that printers produce, using an internationally developed standard called CIE Lab, which defines color numerically. Each letter in the word *Lab* refers to a value: The *L* value indicates how light an object's color is; the *a* value indicates where an object's color falls on a red-to-green scale; and the *b* value indicates where an object's color falls on a yellow-to-blue scale.

We began by using Adobe Photoshop 3.0 to produce pages with solid blocks of cyan, magenta, yellow, red, green, and blue from each printer. We then set the Macintosh-based Colortron colorimeter, from Light Source Computer Images (Larkspur, CA), on the colored output (taking readings at five specific points of three sheets per color) to determine the Lab values of these test pages. By plugging these values into a formula, we arrive at a score reflecting each printer's ability to consistently reproduce individual colors. We arrive at a second score that indicates the gamut, or the range, of colors each printer can produce.

Of the four color laser printers we tested, our results indicate that the Xerox 4900 Color Laser Printer reproduces colors the most consistently. The Tektronix Phaser 540 reproduces the largest range of colors.

Contributors

Michele Guy, Project Manager/NSTL, *led the testing for this project. She has conducted hardware and software testing for NSTL on a variety of products over the past four years.*

John McDonough, Technical Writer/NSTL, *has covered the computer industry for eight years.*

Maggi Bender *is a Technical Analyst for NSTL.*

Tom McAndrew *is a Technical Analyst for NSTL.*

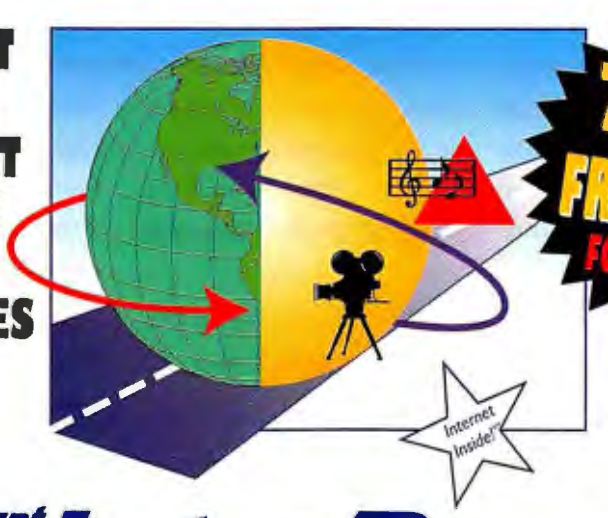
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ROLL CALL OF PRINTERS TESTED

FEATURES CONTINUE ON NEXT PAGE

11- TO -30-PPM LASER

VENDOR	MODEL	PRICE/ MEMORY AS TESTED	GENERAL OVERALL/ PERFORMANCE SCORES	FEATURES/ USABILITY SCORES	ENGINE MODEL	MEMORY BASE/ MAXIMUM	MAXIMUM RESOLUTION HORIZONTAL/ VERTICAL (DPI)	PAGES PER MINUTE MONOCHROME/ COLOR	AUTO-SWITCHING BETWEEN INPUTS/ EMULATIONS
Apple Computer, Inc.	LaserWriter 16/600 PS [1]	$2429/8 MB	7.35/7.49	7.12/5.51	Canon ZX	8 MB/32 MB	600/600	17/N/A	●/●
Canon Computer Systems, Inc.	LBP-1260	$2298/6 MB	6.78/5.93	6.49/7.69	Canon LBP-1260	2 MB/34 MB	600/600	12/N/A	●/●
Dataproducts Corp.	Typhoon 20 [1]	$7255/32 MB	7.81/8.18	7.63/7.60	Fuji-Xerox XP-20	8 MB/72 MB	800/800	20/N/A	●/●
Digital Equipment Corp.	DEClaser 3500 [1,2,3]	$2298/7 MB	6.40/5.88	6.46/6.83	Fuji-Xerox XP-12	3 MB/19 MB	800/600	12/N/A	●/●
Hewlett-Packard Co.	LaserJet 4MV	$3549/12 MB	7.71/8.03	6.85/7.34	Canon C3142S	12 MB/44 MB	600/600	16/N/A	●/●
BYTE Kyocera Electronics, Inc.	Ecosys FS-3600A	$4482/6 MB	8.11/10.00	5.79/4.71	Kyocera FS-3600A	2 MB/66 MB	600/1200	18/N/A	●/●
BYTE Lexmark International, Inc.	Optra Rx [1,4]	$2898/12 MB	7.71/7.54	6.98/8.40	Lexmark Optra	4 MB/64 MB	1200/1200	16/N/A	●/●
QMS, Inc.	1660 Print System [1]	$4899/24 MB	7.61/7.67	6.84/7.20	Canon BX-II	24 MB/64 MB	1200/600	16/N/A	●/●
Texas Instruments	microLaser PowerPro [1]	$1639/6 MB	7.01/7.01	6.56/6.14	Sharp JX9612	6 MB/22 MB	600/600	12/N/A	●/●
Xante Corp.	Accel-a-Writer 8200 [1,4]	$7990/48 MB	7.23/6.71	7.71/7.06	Canon LBP-BXII	12 MB/64 MB	1200/1200	16/N/A	●/●

6- TO 10-PPM LASER

BYTE Digital Equipment Corp.	DEClaser 5100 [1]	$1599/6 MB	6.25/4.44	6.67/8.77	Canon LBP-Ex	6 MB/66 MB	600/600	8/N/A	●/●
Epson America, Inc.	ActionLaser 1600	$1199/4 MB	5.62/3.84	5.48/7.74	Minolta	2 MB/64 MB	600/600	6/N/A	●/●
Fujitsu Computer Products	PrintPartner 8000 [1]	$1186/5 MB	5.41/4.59	2.58/7.00	Fujitsu CA02417-B511	1 MB/9 MB	300/300	8/N/A	○/○
Kyocera Electronics, Inc.	Ecosys FS-1600A	$2464/6 MB	6.36/5.75	5.79/6.54	Kyocera FS-1600	2 MB/66 MB	600/1200	10/N/A	●/●
Mannesmann Tally Corp.	T9008 Laser [1,4]	$1768/6 MB	5.70/4.51	5.51/6.37	TEC LB3500	2 MB/32 MB	600/600	8/N/A	●/●
NEC Technologies	SuperScript 660i [1]	$999/6 MB	5.15/3.42	4.35/7.57	NEC 660i	2 MB/50 MB	600/600	6/N/A	○/Opt.
BYTE QMS, Inc.	1060 Print System [1]	$2399/8 MB	6.58/5.68	6.85/6.94	Minolta SP-10X	8 MB/64 MB	600/600	10/N/A	●/●
Xante Corp.	LaserPress 1200 [1,4]	$7495/24 MB	4.82/2.28	8.03/7.66	Toshiba TN-7270	24 MB/64 MB	1200/1200	8/N/A	●/●

COLOR INK-JET

Canon Computer Systems, Inc.	BJC-4000	$399/64 KB	3.49/0.86	3.49/7.52	Canon BJC-4000	64 KB/64 KB	720/360	5/0.8	○/○
Canon Computer Systems, Inc.	BJC-600e	$549/60 KB	3.89/1.41	3.49/6.70	Canon BJC-600e	60 KB/60 KB	720/360	3/1	○/○
Digital Equipment Corp.	colorwriter 120ic [2]	$355/128 KB	3.55/2.06	3.31/8.33	Olivetti JP360	128 KB/128 KB	300/300	2/0.3	○/○
Digital Equipment Corp.	colorwriter 520ic [2]	$449/128 KB	4.06/4.06	4.01/7.81	Olivetti JP450	128 KB/384 KB	300/300	5/0.3	○/○
Epson America, Inc.	Stylus Color Ink Jet	$699/64 KB	4.06/1.83	5.10/8.04	Seiko Epson Proprietary	64 KB/64 KB	720/720	2–3/3–6	●/●
Lexmark International, Inc.	ExecJet IIc [5]	$379/21 KB	4.03/1.99	3.73/7.26	Lexmark 4076-02C	21 KB/1 MB	300/300	3/2.5–7 min. per page	○/○
BYTE Tektronix, Inc.	Phaser 140	$2091/12 MB	4.31/0.82	5.34/8.00	Canon 4686	8 MB/24 MB	360/360	2/1	●/○

COLOR LASER

Hewlett-Packard Co.	Color LaserJet	$7604/12 MB	5.12/4.28	4.11/7.06	Konica C3100A	8 MB/72 MB	300/300	10/2	●/●
QMS, Inc.	magicolor Laser Printer [1,3]	$8999/28 MB	5.23/2.91	6.73/7.23	Hitachi SL-E	12 MB/64 MB	600/600	8/2	●/●
Tektronix, Inc.	Phaser 540 [1]	$10,785/ 32 MB	4.58/1.87	5.85/5.91	KME 4676	20 MB/52 MB	600/600	14/3.5	●/●
BYTE Xerox Corp.	4900 Color Laser Printer [1]	$9444/24 MB	5.73/3.72	6.88/6.71	Hitachi	12 MB/48 MB	1200/300	12/3	●/●

BYTE = BYTE Best. ● =yes; ○ = no; N/A = not applicable. All printers provide a Centronics parallel port.

[1] Comes with Hewlett-Packard PCL5 emulation.

[2] Comes with Hewlett-Packard DeskJet 500/500C/550C emulation.

[3] Comes with Hewlett-Packard PCL5C emulation.

[4] Comes with Hewlett-Packard PCL4 emulation.

[5] Optional Hewlett-Packard DeskJet 500/500C/550C emulation.



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11- TO 30-PPM LASER

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Apple Computer, Inc.	LaserWriter 16/600 PS [1]	N/A/37,500	●/○	●	●/●/○	●	○/●	4	●
Canon Computer Systems, Inc.	LBP-1260	N/A/20,000	●/○	○	Opt./Opt./○	●	○/●	3	●
Dataproducts Corp.	Typhoon 20 [1]	N/A/50,000	Opt./Opt.	●	Opt./●/Opt.	●	○/●	4	●
Digital Equipment Corp.	DEClaser 3500 [1,2,3]	N/A/20,000	●/●	○	Opt./●/○	●	●/●	3	●
Hewlett-Packard Co.	LaserJet 4MV	N/A/35,000	Opt./Opt.	○	●/●/Opt.	●	○/●	3	●
BYTE Kyocera Electronics, Inc.	Ecosys FS-3600A	N/A/50,000	Opt./○	○	Opt./Opt./Opt.	○	●/○	4	Opt.
BYTE Lexmark International, Inc.	Optra Rx [1,4]	N/A/40,000	●/●	○	Opt./Opt./Opt.	●	●/●	2	Opt.
QMS, Inc.	QMS 1660 Print System [1]	3000 hours /35,000	●/○	●	Opt./●/Opt.	●	●/●	2	Opt.
Texas Instruments	microLaser PowerPro [1]	N/A/10,000	Opt./Opt.	●	Opt./●/○	○	○/●	2	Opt.
Xante Corp.	Accel-a-Writer 8200 [1,4]	N/A/10,000	●/○	●	Opt./●/○	●	●/●	3	Opt.

6- TO 10-PPM LASER

VENDOR	MODEL	MTBF/ MONTHLY DUTY CYCLE (PAGES)	INTERFACES: RS-232/ RS-422A	INTERFACES: SCSI	INTERFACES: ETHERNET/ LOCALTALK/ TOKEN RING	PDLS: HPGL	PDLS: POSTSCRIPT LEVEL 1/ LEVEL 2	MAXIMUM NUMBER OF INPUT TRAYS	LEGAL (8.5 × 14 IN.)
BYTE Digital Equipment Corp.	DEClaser 5100 [1]	N/A/20,000	●/●	○	Opt./●/○	○	○/●	3	●
Epson America, Inc.	ActionLaser 1600	4000 hours/11,000	●/●	○	Opt./Opt./○	●	○/Opt.	2	●
Fujitsu Computer Products	PrintPartner 8000 [1]	4000 hours/3000	Opt./○	○	Opt./Opt./○	○	Opt./○	1	○
Kyocera Electronics, Inc.	Ecosys FS-1600A	N/A/25,000	Opt./○	○	Opt./Opt./Opt.	○	●/○	4	Opt.
Mannesmann Tally Corp.	T9008 Laser Printer [1,4]	3000 hours/20,000	●/○	○	Opt./Opt./Opt.	●	○/Opt.	3	●
NEC Technologies	SuperScript 660i [1]	N/A/2500	○/○	○	○/○/○	●	○/Opt.	1	●
BYTE QMS, Inc.	QMS 1060 Print System [1]	3000 hours/10,000	●/○	●	Opt./●/Opt.	●	●/●	3	Opt.
Xante Corp.	LaserPress 1200 [1,4]	N/A/5000	●/○	●	●/●/○	●	●/●	3	●

COLOR INK-JET

VENDOR	MODEL	MTBF/ MONTHLY DUTY CYCLE (PAGES)	INTERFACES: RS-232/ RS-422A	INTERFACES: SCSI	INTERFACES: ETHERNET/ LOCALTALK/ TOKEN RING	PDLS: HPGL	PDLS: POSTSCRIPT LEVEL 1/ LEVEL 2	MAXIMUM NUMBER OF INPUT TRAYS	LEGAL (8.5 × 14 IN.)
Canon Computer Systems, Inc.	BJC-4000	N/A/N/A	○/○	○	○/○/○	○	○/○	1	●
Canon Computer Systems, Inc.	BJC-600e	N/A/N/A	○/○	○	○/○/○	○	○/○	1	●
Digital Equipment Corp.	colorwriter 120ic [2]	N/A/1000	○/○	○	○/○/○	○	○/○	1	●
Digital Equipment Corp.	colorwriter 520ic [2]	N/A/1000	Opt./○	○	○/○/○	○	○/○	2	●
Epson America, Inc.	Stylus Color Ink Jet Printer	4000 hours/N/A	○/●	○	○/●/○	○	○/○	1	●
Lexmark International, Inc.	ExecJet IIc [5]	N/A/2000	Opt./Opt.	○	○/○/○	○	○/○	1	●
BYTE Tektronix, Inc.	Phaser 140	12,000 copies/3400 color	○/○	○	Opt./●/○	○	●/●	1	●

COLOR LASER

VENDOR	MODEL	MTBF/ MONTHLY DUTY CYCLE (PAGES)	INTERFACES: RS-232/ RS-422A	INTERFACES: SCSI	INTERFACES: ETHERNET/ LOCALTALK/ TOKEN RING	PDLS: HPGL	PDLS: POSTSCRIPT LEVEL 1/ LEVEL 2	MAXIMUM NUMBER OF INPUT TRAYS	LEGAL (8.5 × 14 IN.)
Hewlett-Packard Co.	Color LaserJet	N/A/15,000	Opt./Opt.	○	Opt./Opt./Opt.	●	○/Opt.	2	●
QMS, Inc.	magicolor Laser Printer [1,3]	3000/5000	●/○	●	Opt./●/Opt.	●	●/●	2	●
Tektronix, Inc.	Phaser 540 [1]	N/A/20,000	Opt./○	●	Opt./Opt./Opt.	●	●/●	3	○
BYTE Xerox Corp.	4900 Color Laser Printer [1]	N/A/15,000	●/○	○	Opt./●/Opt.	●	●/●	2	●

BYTE = BYTE Best. ● =yes; ○ = no; N/A = not applicable. All printers provide a Centronics parallel port.

[1] Comes with Hewlett-Packard PCL5 emulation.

[2] Comes with Hewlett-Packard DeskJet 500/500C/550C emulation.

[3] Comes with Hewlett-Packard PCL5C emulation.

[4] Comes with Hewlett-Packard PCL4 emulation.

[5] Optional Hewlett-Packard DeskJet 500/500C/550C emulation.

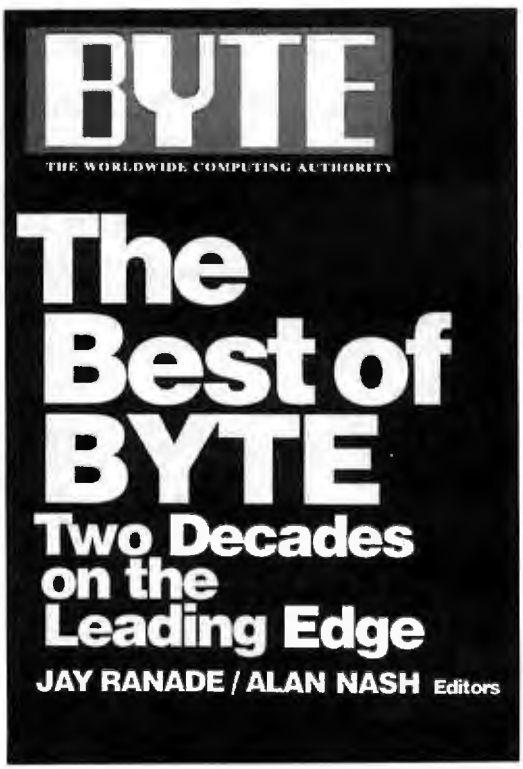
SUPPORTED PAPER SIZES				ENVELOPE/ OHP FILM/ ADHESIVE-BACKED LABELS	DIMENSIONS IN INCHES (W × D × H)	WEIGHT (LBS.)	FCC CLASS/ OPERATING-NOISE LEVEL (DECIBELS)	WARRANTY: * YEARS + COVERAGE	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
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●	●	●	○	●/●/○	16.7 × 16.9 × 12.1	40	B/43	1 PLRC	(408) 996-1010	(800) 538-9696	1346
●	●	●	○	●/●/●	17 × 16 × 12	37	B/49	2 PL	Call local Canon dealer	(800) 848-4123	1347
●	●	●	●	●/●/●	20.5 × 21.5 × 16	75	A/53	1 PL	(703) 648-0930	(800) 980-0374	1348
●	○	●	○	Opt./●/●	14.4 × 16 × 10.5	28	A/50	1 PL	(508) 493-5111	(800) 777-4343	1349
●	●	●	●	●/●/●	18.1 × 20.6 × 12.5	51	B/55	1 PL	Call local HP dealer	(800) 752-0900	1350
Opt.	○	●	○	Opt./●/●	13.6 × 13.8 × 9.7	24	B/50	1 PL	(908) 560-3400	(800) 232-6796	1351
●	●	Opt.	○	Opt./●/●	16.1 × 21.1 × 13.1	42	B/50	1 PLRC	(606) 232-2000	(800) 891-0331	1352
Opt.	Opt.	●	●	○/●/●	18 × 23.2 × 11.8	50	A/49	1 PL	(205) 633-4300	(800) 523-2696	1353
Opt.	○	○	○	Opt./●/●	13 × 14.4 × 12.8	32	B/48	1 PL	(512) 794-5970	(800) 848-3927	1354
●	Opt.	●	●	○/●/●	17.9 × 20.3 × 11.7	60	A/48	1 PLRC	(205) 476-8189	(800) 926-8839	1355
●	○	●	○	●/●/●	16.4 × 15.9 × 11.7	37	B/48	1 PL	(508) 493-5111	(800) 777-4343	1356
●	●	●	○	●/●/●	14.5 × 18 × 9	22	B/47	2 PL	(310) 782-0770 ext. 3000	(800) 289-3776	1357
●	○	○	○	○/●/●	15.2 × 13.6 × 5.1	16	B/48	1 PL	(408) 432-6333	(800) 626-4686	1358
Opt.	Opt.	●	○	Opt./●/●	13.6 × 13.8 × 9.7	24	B/50	1 PL	(908) 560-3400	(800) 232-6796	1359
●	●	●	○	●/●/●	15.5 × 14.5 × 11.2	37	B/45	1 PL	(206) 251-5524	(800) 843-1347	1360
●	●	●	○	●/●/●	14.6 × 14.1 × 9.3	17.6	B/48	2 PLRC	(508) 264-8000	(800) 632-4636	1361
Opt.	○	●	○	Opt./●/●	16.2 × 19 × 14.3	38	A/47	1 PL	(205) 633-4300	(800) 523-2696	1362
●	●	●	●	○/●/●	19.3 × 17.9 × 8.3	51	A/52	1 PLRC	(205) 476-8189	(800) 926-8839	1363
●	●	●	○	●/●/○	14.4 × 21 × 10	7.9	B/45	2 PL	Call local Canon dealer	(800) 848-4123	1364
●	●	●	○	●/●/○	16.1 × 19.7 × 15.7	9.9	B/45	2 PL	Call local Canon dealer	(800) 848-4123	1365
●	○	●	○	●/●/○	14.2 × 14.2 × 11	8.3	B/42	2 PL	(508) 493-5111	(800) 777-4343	1366
●	○	●	○	●/●/●	18.2 × 20.1 × 8.1	11	B/45	2 PL	(508) 493-5111	(800) 777-4343	1367
●	●	●	○	●/●/○	18.5 × 20.5 × 7.5	16	B/47	2 PL	(310) 782-0770	(800) 289-3776 ext. 3000	1368
●	●	●	○	●/●/●	11.1 × 14.3 × 10.6	11	B/45	2 PLRC	(606) 232-2000	(800) 438-2468	1369
●	○	○	○	●/●/●	12.2 × 16.5 × 7.5	14.2	B/45	1 PLRC	(503) 682-7377	(800) 682-7377	1370
●	○	●	●	○/●/○	24.4 × 14.8 × 19.3	102.5	B/52	1 PL	Call local HP dealer	(800) 752-0900	1371
●	○	●	○	○/●/●	20.5 × 22.2 × 14.6	86	A/58	1 PL	(205) 633-4300	(800) 523-2696	1372
●	○	○	○	○/●/○	27.4 × 19.5 × 18	117	B/53	1 PLRC	(503) 682-7377	(800) 682-7377	1373
●	○	●	○	Opt./●/●	24 × 21.7 × 15	108	B/55	1 PLRC	(716) 256-4446	(800) 349-3769	1374

* Warranty: P = parts; L = labor; RC = freight to repair center.

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McGRAW-HILL, INC.

ColdFire: A Hot Architecture

This new implementation renews a proven embedded architecture

JOE CIRCELLO

Motorola's 68000 family of microprocessors has served both the computer and the embedded markets well. Now the PowerPC has created an opportunity for the 68000 family to refocus entirely on embedded systems, making it possible to redefine the architecture to achieve dramatic improvements in both cost and performance relative to the older 68000-family designs. A new architecture, called ColdFire, is the result of such a refocus and represents an approach targeted at the emerging needs of advanced consumer-electronics applications.

ColdFire's designers set several requirements for the architecture they would create for this new class of cost-sensitive embedded applications. Obviously, they demanded a low-cost architecture, most of which they achieved by using a small core size. A small die also let them integrate on-chip memories, system modules, and peripherals cost-effectively. ColdFire offers abundant processing power, so it can tackle computer-intensive jobs while consuming relatively little electrical power.

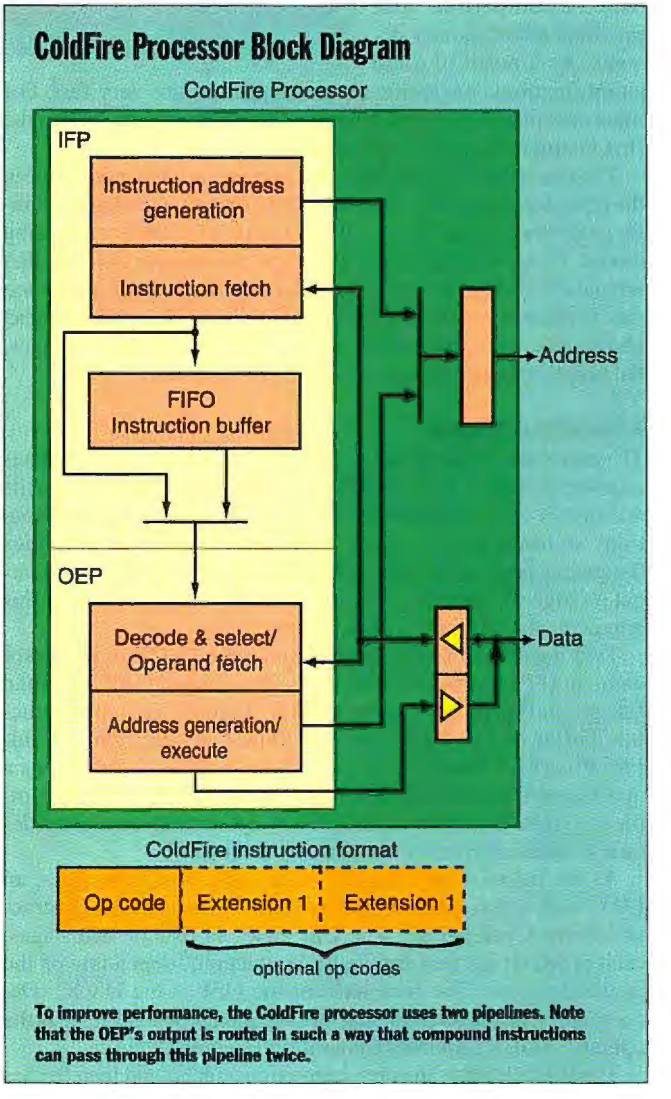
Finally, ColdFire employs a high-density ISA (instruction-set architecture), especially important because in many embedded systems the memory subsystem's cost far exceeds the processor's cost. A high-density ISA minimizes the application's storage requirements, which thus reduces overall system cost. The original 68000 processor ISA provided the starting point for ColdFire's ISA. Like the 68000 ISA, ColdFire defines a variable-length ISA to achieve optimum code density. This is accomplished in a RISC-based implementation that provides a very efficient silicon design.

Changes in Instruction

Other important changes were made to the 68000 ISA instruction set while still maintaining the original programming model. Certain operations had either reduced support or were eliminated, which makes for a simpler and smaller core. Examples of the changes to the instruction set are reduced support for byte- and word-size operands, reduced support for RMW (read-modify-write) instructions, and removal of instructions used primarily by desktop applications, such as the trap on overflow exception, and BCD (binary-coded decimal) arithmetic.

Let's look at these changes in more detail: For byte- and word-size operands, the instructions supporting arithmetic and logical operations were removed. However, ColdFire keeps those op codes performing simple assignments (e.g., `move`) and the Test and Clear functions. While support for RMW operations was reduced, ColdFire retains the op codes performing arithmetic and logical functions using a program-visible register and memory. A number of instructions, including those involving BCD operands, rotate op codes, and integer divides, were simply deleted. The Divide instruction was eliminated because the transistor count needed to support these op codes could not be justified. A software Divide routine has been developed that actually uses less machine cycles than does the 68000 for most operands.

A number of extensions were made to the original 68000 ISA when the 68020 microprocessor was introduced. The ColdFire architecture implements several important instructions from these additions, including a 32- by 32-bit



To improve performance, the ColdFire processor uses two pipelines. Note that the OEP's output is routed in such a way that compound instructions can pass through this pipeline twice.

integer multiply that produces a 32-bit result, a complete set of register sign-extension instructions, scale factors (x1, x2, x4) for indexed addressing modes, and multiple-word NOP (No Operation) instructions. Compilers use the latter to remove branch instructions.

Taking Exception

In addition to these areas of instruction-set simplification, the ColdFire exception processing model is streamlined. The architecture defines a single 8-byte frame created for all exception types on a self-aligning system stack (i.e., the stack pointer automatically compensates for misaligned data before creating an exception frame). After ColdFire creates the stack frame, it fetches an exception vector from a 1024-byte table that defines the location of the first instruction of the service routine. Thus, the processing of system calls and external interrupts remains exactly compatible with previous 68000-family designs. As a result of these simplifications, exception processing times are very fast. For most exceptions, the time from the faulting instruction until the first instruction in the service routine is a mere 12 cycles.

COMPARING COLDFIRE TO OTHER 68000 DESIGNS

	68EC000	68040V	COLDFIRE
Process technology	0.8 µ 3.3 V, DLM	0.5 µ 3.3 V, TLM	0.5 µ 3.3 V, TLM
Core size (sq mm)	11.6	16.4	4.4
Frequency (MHz)	16.67	25	50
On-chip cache	None	4 KB instruction, 4 KB data	4 KB unified
External bus (bits)	16	32	32
Performance			
Embedded code	1.0x	1.6x	2.2x
Dhrystone MIPS	2.1	24.6	44.3
MIPS/watt	42	30	197

The resulting ColdFire ISA then represents a balance between the core size and code expansion, while retaining the 68000-family programming model with its powerful set of basic addressing modes. The static size of embedded applications in the ColdFire ISA is typically 20 percent to 40 percent less than fixed-length instruction sets. In relation to its predecessor, the ColdFire ISA produces object images that are considerably smaller than 68000 object images, but not as compact as objects targeted for the 68040.

A Tale of Two Pipelines

The hardware implementation of the ColdFire architecture uses a synthesis-driven, tools-based design philosophy. This allows the addition of optional hardware modules that provide custom functions and tune the processor's performance. It also provides design independence across different process technologies that target a range of operating frequencies and voltages. Finally, this approach also produces quick design cycles.

Two decoupled pipelines implement the ColdFire processor core: an IFP (Instruction Fetch Pipeline) and an OEP (Operand Execution Pipeline). A 12-byte FIFO (first-in/first-out) instruction buffer decouples the two pipelines (see the figure "ColdFire Processor Block Diagram"). Note that the core features a non-Harvard implementation to minimize die size and bus complexity. Studies indicate a full Harvard architecture provides only a minimal improvement in performance.

As the figure shows, the IFP itself consists of two stages, an IAG (Instruction Address Generation) stage and an IC (Instruction Fetch Cycle) stage. The OEP also consists of two stages, each of which can perform multiple functions, depending on the instruction type. The first stage of the OEP is the DSOC (Decode and Select/Operand Fetch Cycle), and the second stage is the operand AGEX (Address Generation/Execute Cycle).

The IFP calculates the next instruction address and then fetches 32 bits of instruction data using the single-cycle processor/memory bus. Typically, the processor is connected to an on-chip memory, either in the form of a RAM/ROM structure or a unified cache. As the fetched instruction enters the processor, it is loaded into the FIFO instruction buffer. If the OEP is waiting for instruction data, the prefetched instruction is also gated directly into its instruction registers. The connection between the two pipelines is a 48-bit interface, a ColdFire instruction's maximum size. The ColdFire architecture's variable-length instructions include a 16-bit op code, an optional 16-bit extension word 1, and an optional 16-bit extension word 2. The IFP connected to the FIFO instruction buffer provides a very efficient mechanism for loading the variable-length ColdFire instructions into the OEP with a minimum of idle cycles.

The OEP is based on the traditional RISC compute engine structure with a dual read-ported register file feeding an ALU. Register-to-register instructions are executed in a single pipeline cycle with the operands fetched during the OC (Operand Fetch Cycle) phase of the OEP pipeline, and the actual execution is performed in the EX (execute) phase of the OEP pipeline.

The ColdFire ISA is not a pure load/store architecture, so there are numerous compound instructions that combine a load operation with some type of arithmetic or logical operation. These "embedded-load" instructions essentially pass through the OEP twice. This type of instruction begins by selecting the components needed to form the operand address in the DS (decode and select) phase of the OEP's first stage. Next, the ALU sums the components to form the operand address during the AG (address generation) phase in the pipeline's second stage. During the third cycle, memory is read and the desired operand returned to the core. At the same time, any required register operand is fetched during the OC phase in the OEP pipeline. Finally, the instruction is actually executed in the ALU during the EX phase in the OEP pipeline. Register store operations perform both functions (DS + OC, and AG + EX) simultaneously in each stage of the OEP to execute the instruction in a single cycle.

The results of the ColdFire design can be seen in the table above. It compares today's 68000 design (the 68EC000), the latest 68040 design, and a possible ColdFire implementation. The ColdFire architecture provides 68040 levels of performance at a given frequency in a core size smaller than the original 68000 design. The RISC-based implementation approach provides higher operating frequencies while still maintaining the advantages of a variable-length ISA. For cost-driven embedded systems, this variable-length ISA can provide substantial benefits over a fixed-length approach. Additionally, this new architecture maintains compatibility with the substantial 68000-family embedded development tool sets and preserves the knowledge base of engineers and programmers. ■

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NetWare 4.1 Forges Ahead

More capable and less expensive than version 4.0, 4.1 is the version Novell hopes will finally lure you away from NetWare 3.xx

BARRY NANCE

Some customers who bought version 4.0 of NetWare felt like beta testers. The NOS (network operating system) was incomplete and not as reliable as they'd have liked it to be. In December 1994, Novell announced NetWare 4.1. CD-ROM shipments began in January, and floppy disk shipments began in late February. Novell expects the NOS market to migrate quickly to NetWare 4.1.

To encourage that migration, Novell has set the price of NetWare 4.1 at 3.xx levels. In response to complaints about the coarse granularity of NetWare's licensing scheme, Novell now lets you combine, for instance, a 150-user license and a 25-user license to additively create a 175-user installation of NetWare. Novell also announced that purchasers of SFT III (System Fault Tolerant) NetWare will get version 4.1 for free, including the SFT III add-on component for version 4.1. (NetWare 4.1 incorporates SFT III, but the functions are disabled. You use a license disk to enable SFT III.)

Strong competition from Microsoft's NT Server 3.5 and IBM's LAN Server 4.0 may steal some of NetWare 4.1's thunder, but it's a robust and reliable product. It features NDS (NetWare Directory Services), integrated messaging in the form of an integrated multimail-protocol MHS, multiprotocol routing, network management, security, and the usual file- and printer-sharing services.

Additionally, version 4.1 includes several important functions for large, mission-critical LANs: the use of TCP/IP or IPX for transmitting file service packets, NLSP (NetWare Link Services Protocol), NetWare for Macintosh, and new VLMs (virtual loadable modules) for the client workstations. Version 4.1 also includes support for NetWare for OS/2 and for mirroring file servers using the SFT III technology.

NetWare's Unique Architecture

Version 4.1 behaves much the same as earlier versions of NetWare. For better or worse, it carries in its basic architecture the legacy of the original NetWare developed in the early 1980s. NetWare 4.1, like earlier versions of Novell's server-based network software, is a tightly integrated combination of OS and NOS—you can't install one component without the other. This architectural foundation is the single biggest distinction between NetWare and its competitors, which offer a separate OS environment on the file server. The wealth of features in NetWare 4.1 notwithstanding, the unique architecture of NetWare remains both its greatest strength and biggest shortcoming.

Like earlier versions, NetWare 4.1 doesn't offer virtual memory (i.e., overcommitment of memory through the use of a disk file for swapping or paging). Version 4.1 also doesn't offer the sort of crash protection that NT and OS/2 do, nor does it offer preemptive multitasking. To its credit, NetWare 4.1 can run NLMs (NetWare loadable modules) in ring 3 or ring 0 (as could version 4.0). Furthermore, it can dynamically load and unload device drivers, a feature most OSes and environments lack.

Novell's programmers have optimized NetWare for file and printer sharing. NLM-based SQL servers are available—from Oracle, Sybase, and many others—but LAN administrators know that running NLMs on a NetWare server can sometimes be risky. NLMs can achieve outstanding performance because NetWare can service client requests in remarkably few instructions. However, I've always believed that you should cross your fingers and wear garlic when you load NLMs on a production server.

On a large LAN, dedicating a PC as a file server makes sense. On a smaller LAN, you might want your file server to run application-oriented background programs, such as a calculation engine or a data formatter. Unless you master the arcane art of developing NLMs, you will not be able to run custom-written software on the file server. NetWare is an excellent file- and printer-sharing environment, but NT Server and LAN Server are better application server environments. Novell acknowledges this fact, and it therefore plans to unify the file-serving and routing capabilities of NetWare with the application-serving strengths of UnixWare to create what will be an all-purpose "SuperNOS."

NETWARE 4.1'S AGGRESSIVE PRICING

The list prices for NetWare 4.1 are the same as those for version 3.xx and about 25 percent less than version 4.0 prices. A new additive licensing verification scheme in version 4.1 lets you combine items in the table in creative ways. For 275 users, you can buy the 250-user version and the 50-user version. Novell doesn't require you to buy the 500-connection license if you need only 275 concurrent connections for the people in your organization.

NUMBER OF CONNECTIONS	PRICE
5	$1095
10	$2495
25	$3695
50	$4995
100	$6995
250	$12,495
500	$24,995
1000	$47,995

Working with Version 4.1

NetWare 4.1 is bigger than previous versions. Novell claims it requires an absolute minimum of 8 MB of RAM

in the server. Of course, a file server is often a good place to install lots of RAM, and you shouldn't skimp on RAM—it tends to help the server perform faster. However, NetWare 4.1 will install on an 8-MB machine if you do some of the installation tasks by hand. The installation program plus 4.1 itself consume close to 8 MB, so you might not be able to complete the installation on an 8-MB machine.

NDS is more than just a replacement for the bindery files in which earlier versions of NetWare stored log-on accounts, passwords, server names, and other administrative data. While the bindery files were a keyed, hierarchical set of named properties and their values, NDS is a distributed, pseudorelational database of network administrative data that can replicate among version 4.1 servers in a multiserver enterprise.

NDS treats all network resources as tree-structured objects in the distributed NDS database. Network managers run NetAdmin on DOS workstations or NetWare Administrator on Windows or OS/2 workstations to make changes to the network configuration (NetAdmin doesn't yet run on NT workstations). Note that NDS uses a period to denote levels of the NDS tree. Before you upgrade to NetWare 4.1, you'll want to identify and change any log-on account names that contain periods.

Many NetWare-compliant utilities and network extensions use the older bindery APIs. Until third-party utility vendors and Novell itself replace their bindery API calls with NDS API calls, Novell will provide *bindery emulation*. This is an insulating layer of functions that internally translate bindery API calls (e.g., `SetPropertyValue()`) to their NDS equivalents. Unfortunately, the bindery emulation in version 4.1 still isn't perfect.

A Few Gotchas

NetWare NFS is an example of a network extension that relies on bindery emulation. A forthcoming version will support NDS natively. Until that happens, however, be aware that the NetWare NFS for version 3.11 of NetWare doesn't work well with NetWare 4.1's bindery emulation. In particular, on a LAN already running NFS, the 4.1 migration process loses NFS properties for files and directories.

Granting all rights to a directory (via NWAdmin, Syscon, or NetAdmin) for a log-on account causes NFS to report that the directory is owned by the dummy account NFSAdmin and has readable-by-anyone NFS properties (i.e., RWXR-XR-X). If you use a Unix command to set a directory's rights to readable-writable-executable for a single log-on account, NetWare reports that members of the Everyone group have read access to the directory. If you use NetWare NFS, you'll want to obtain the new version of it before installing version 4.1.

VLM clients can also support connections to both 3.xx and 4.1 servers in bindery emulation mode. Be careful about VLMs, however. VLM client software behaves somewhat differently from the earlier NETX software. Performing a CD (change directory) command in a DOS session under Windows on a NetWare LAN causes all DOS sessions to change to the new directory. Under NETX, DOS sessions retain their individual current directories.

You can add 3.xx servers to a 4.1 NDS tree, which allows client workstations easier access to the 3.11 servers. Attaching to a 3.xx server by simply mapping its volumes is still possible, too. A utility called NetSync, which integrates your 3.xx servers with NDS, is a standard part of version 4.1. However, you shouldn't run NetSync until you're ready for your 4.1 primary server to assume full responsibility for the bindery files in the 3.xx servers. The 3.xx servers become irrevocable slaves to the 4.1 NDS once you've run NetSync.

NetWare 4.1 (as did version 4.0) offers disk block suballocation and on-the-fly file compression. You can enable both suballocation and compression on an upgraded 3.11 server simply by loading Install after you have completed the upgrade. Select Maintenance/Selective Install/Volumes Options and then the volume you wish to modify. Move down to the block suballocation and compression fields and turn them on. The only thing you can't change with an in-place upgrade is the block size. To change this, you must make a backup copy of the volume, delete it, re-create it with the new features, and restore the data.

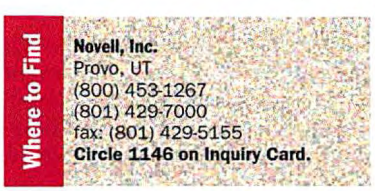
If you have 4.0x NetWare servers on your LAN, be aware that Novell made significant enhancements and changes to the NDS file structures. Make sure that the server with the primary NDS replica remains 4.0x until you upgrade all the existing secondary replicas on 4.0x servers to NetWare 4.1. As a last step, upgrade the primary server to version 4.1. If you upgrade the server containing the primary NDS image first, you'll likely have problems with Directory Services on all the 4.0x servers because they don't recognize the new 4.1 NDS formats.

Other Enhancements

The new link state router for IPX, NLSP, helps IPX use WAN links wisely and frugally. NLSP is based on a routing strategy termed OSPF (Open Shortest Path First), which overcomes the limitations and high WAN traffic of the older RIP (Routing Information Protocol) and SAP (Service Advertising Protocol). NLSP is faster than RIP at determining alternate routing paths between servers and networks. It supports SNMP, balances routing loads across multiple paths, and causes much less WAN traffic than RIP. NLSP acts as a superset of RIP, accommodating mixed RIP/SAP and NLSP traffic on the same network.

Security, always one of NetWare's strongest features, is even better in version 4.1. Novell has submitted version 4.1 to the government for C-2 level certification at the "Red Book" (i.e., entire network) level (for comparison, NT Server is certifiable only at the "Orange Book," or single-node, level). Version 4.1 uses RSA public-key encryption and packet signatures to enhance LAN security.

If you'd like to see the NetWare 4.1 manuals before buying the product, they and the DynaText viewer are on ftp.novell.com, ftp.netcom.com, and various Novell mirror sites. Novell also maintains www.netware.com, a somewhat new Web server for NetWare-specific information.



NetWare 4.1's benefits are most obvious on LANs with more than 250 log-on accounts or more than eight file servers. Earlier versions of NetWare simply couldn't support larger LANs without a lot of fiddling to keep the maximum number of connections or maximum attached servers below the system limits that version 3.xx imposed. Large organizations that are straining against the 3.xx limits—and the hassles of multiserver administration—will find considerable relief in version 4.1. ■

Barry Nance is a programmer, a BYTE consulting editor, and the author of Using OS/2 Warp *(Que, 1994),* Introduction to Networking *(Que, 1994), and* Client/Server LAN Programming *(Que, 1994). You can reach him on the Internet or BIX at barryn@bix.com.*

Adding Apple Events to Your Mac Application: Part 1

Adding basic high-level event functions to your program makes it communicate with other applications

TOM THOMPSON

One of the most-hidden features of the System 7 Mac OS is its built-in messaging subsystem. This subsystem, which is called IAC (Interapplication Communication), enables applications to obtain information from other applications or control them, even launching or halting them if necessary to perform a requested operation. Scripting languages such as AppleScript or UserLand Software's Frontier perform automated tasks by using IAC to steer such applications through their paces. However, IAC is not limited to applications. Component software such as OpenDoc parts uses IAC to communicate and act on a document.

If IAC is so cool, why haven't we seen more of it? One reason is because IAC's strength lies in its ability to operate smoothly behind the scenes. For example, let's say you drag and drop several JPEG image files on Adobe Photoshop 3.0's application icon. Photoshop automatically launches and displays all the files' contents, each in a separate window. What happened was that the Mac Finder translated your actions into an IAC message that told Photoshop to open the chosen files. You'll never see any evidence of IAC on-screen, but every time you drop and drag or use a script, it's IAC that makes it possible.

The other reason we haven't seen more of IAC is the paucity of information on how to implement it. Note that I didn't say a lack of information. In fact, Addison-Wesley has published the volume *Inside Macintosh: Interapplication Communication*, which at nearly 1000 pages is the ultimate body of information on IAC. However, it is only a reference document, which may make it difficult for the aspiring Mac programmer to get a complete picture of IAC.

What we'll do this month is discuss the purpose of Apple Events and describe a little of their structure. We'll also start showing you how to implement several basic IAC functions in your application. What we don't finish this month we'll complete next month. The basic understanding these columns provide should let you make sense of the reference material. You will then be able to add all the capabilities you need to make your Mac application a good neighbor to other applications—and thus of value to your customer.

The Apple Event

Apple's method for providing access to the Mac OS's IAC mechanism is ingenious. The company defined a new event type that passes IAC messages to and from a program. Because Mac applications already use an event loop to acquire and respond to low-level events posted by the OS (e.g., window updates, keystrokes, and mouse-clicks), a programmer need only add some code to this event loop to field this new event type. These new events are termed *high-level events*, because the messages that they pass require the application to perform more complex operations than what's necessary to handle low-level events.

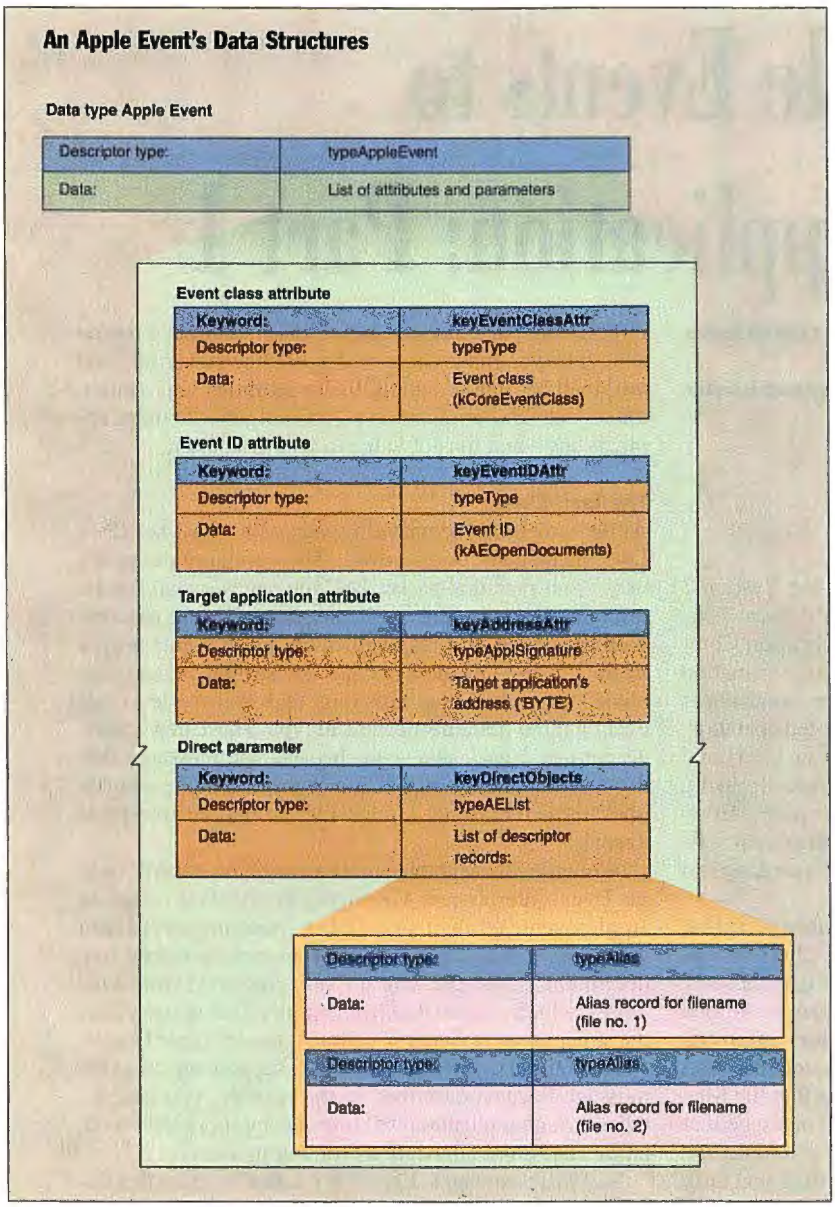
A high-level event that complies with the AEIMP (Apple Event Interprocess Messaging Protocol) is called an Apple Event. While it's possible to pass any sort of data structure through IAC, Apple Events are described in a document called the *Apple Event Registry: Standard Suites*, which is available from Apple. This registry lists the structure and content of certain types of Apple Events, which you can use to implement IAC support. By using the message formats described in the registry, you guarantee that your application will respond appropriately to existing and future applications (or components).

So, what is an Apple Event? It's a data structure that describes the high-level event's type, plus additional information that frames a request or returns data in response to a request. Put another way, it's a structure composed of a

Section of an event loop modified to catch Apple Events and the function to dispatch them.

```
      case updateEvt:         // Update the window
            gwhichWindow = (WindowPtr) gmyEvent.message;
      break;
      case kHighLevelEvent:  // Handle Apple Event
                  Do_High_Level(&gmyEvent);
      break;
      default:
                  break;
      } // end switch gmyEvent.what

void Do_High_Level(EventRecord *AERecord)
{
    AEProcessAppleEvent(AERecord);
} // end Do_High_Level()
```



The organization of a required Apple Event. It's composed as a list of descriptors (i.e., data structures). The Event class and ID identify this event as an Open Documents Apple Event, targeted at an application whose creator is "BYTE." The remaining descriptors are data parameters that contain the filenames requested to be opened.

nested list of structures that describes the characteristics of these structures (hence the name *descriptor*). A descriptor might encapsulate a response for data (e.g., a database query), or it might enclose the name of several files for an application to open (see the figure "An Apple Event's Data Structures").

Each Apple Event is composed of a class and an ID. An Apple Event's class describes the event's category or type, and the ID is a number that specifies a specific event within the class. Each event class is known as a *suite*, because these events are grouped by the type of operation they perform. For example, there are Apple Events for the Required suite, the Text suite, the Database suite, the Telephony suite, the Mail suite, and others.

The Required suite of Apple Events defines four basic operations every Mac application must respond to: Open Application, Open Documents, Print Documents, and Quit Application. The Open Application event tells your application to perform basic setup chores (e.g., opening a new document window or, in a graphics program, allocating buffers and adjusting the color palette). Note that this is not the same thing as application initialization. Instead, it's a way for the application to create a new document.

The Open Documents event orders the application to open the specified files. The Print Documents event has the application print the requested files. The Quit Application event, as its name implies, informs your application to stop running. Due to space limitations, we'll have room to describe how your application can receive and respond to only two of these four Apple Events: Open Application and Quit Application. We'll show you how this can be done in next month's column.

Adding Required Events

Adding support for Apple Events involves four steps. First, you must add the new event type to your main event loop. Second, you must provide the mechanism that directs these events to the appropriate handler functions. Third, you need to write the handlers that respond to these events. Finally, you have to let the OS know that the application can handle high-level events.

Step one involves modifying the main event loop code to look for the new event type, as shown in the code fragment in the listing. Note the use of the constant `kHighLevelEvent`, which is defined in the header file AppleEvents.h. When an Apple Event is detected, we call the function `Do_High_Level()` to process it. This function, which is also shown in the listing, simply passes the captured event structure onto the Mac OS call `AEProcessAppleEvent()`.

`AEProcessAppleEvent()`, which is part of the Mac OS's Apple Event Manager, searches a dispatch table to determine which of the handlers receives the event. The application builds this dispatch table when it is launched, and it contains entries for an event's class and type, along with a pointer to the corresponding handler function. If a matching entry is found, the application's handler is called. If there is no match, the Apple Event Manager searches the OS dispatch table and either finds a default handler or returns an error code.

Where to Find
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(408) 996-1010
fax: (408) 996-0275

Next month, we'll show you how to build the dispatch table and complete the rest of the steps required to add Apple Event functions to your application. ■

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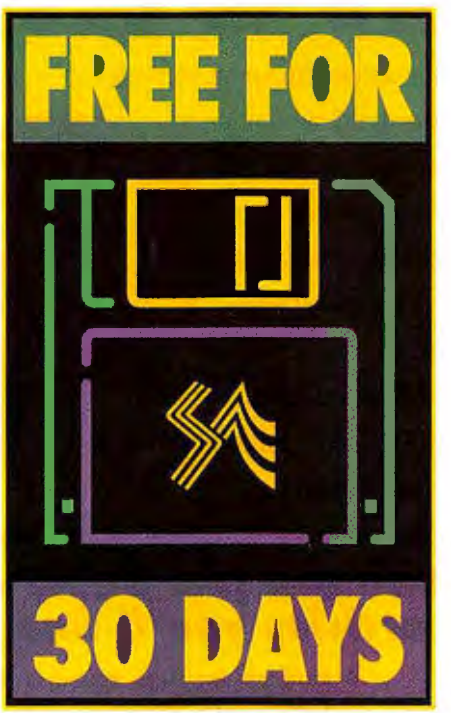
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Virtual LANs Get Real

Switching technology lets companies quickly bring resources together to meet business challenges

SALVATORE SALAMONE

Management guru Tom Peters, who jets across the country giving one-day seminars to Fortune 500 executives at $1500 a pop, frequently talks about how tomorrow's economy will revolve around innovative assembling of brain power. He notes that to meet customers' demands, corporations must be able to quickly bring together in-house knowledge on an ad hoc basis. Virtual LAN technology helps corporations do just that.

In essence, virtual LANs allow companies to form workgroups on the fly. This approach not only lets users share network resources but also provides dedicated bandwidth to each group. This is accomplished without flooding other parts of the corporate network with broadcast traffic that's intended solely for other members of the same group.

Virtual LANs are an outgrowth of switching technologies (Ethernet and ATM) that are making their way into corporate networks. Early virtual LAN solutions came from switching hub vendors, such as Alantec, Chipcom, Lannet, and UB Networks. These solutions were followed by offerings from major internetworking vendors, such as 3Com, Bay Networks, Cabletron Systems, Cisco Systems, Standard Microsystems, and Xyplex.

All these vendors offer a way to take advantage of the port or packet-switching capabilities of their intelligent wiring hubs or switches so that users can be connected based on logical groupings rather than physical location within the company. For example, in a number of organizations, it probably makes sense to form a product development team that includes a systems engineer, a design engineer, a product marketing person, and someone responsible for the financial management of the project.

This group of folks can be scattered throughout the organization, but they need to share information relevant to the project they are working on. In the past, to create such groupings, administrators had to go into wiring closets and physically connect the users to the same LAN segment, which was fine if a group was permanent. However, in today's business environment, it's likely that such groups will be short-lived.

That's where virtual LANs come in. Rather than making frequent trips into wiring closets and physically reconfiguring the network at the hub by moving cables around, administrators can define and create groups in software by issuing commands from a central management console.

To create virtual workgroups, you assign a dedicated portion of a hub's backplane bandwidth to each virtual LAN. Most switching hubs have high-bandwidth backplanes that support multiple, dedicated LAN segments. For example, with Lannet's LANswitch, you can define up to 255 virtual LANs (also with this hub, you can connect users to a "global" virtual LAN).

Once you assign a person to a workgroup, the traffic generated for the other members of the group is confined to that one portion of backplane bandwidth. This reduces congestion on other portions of a network because broadcast packets generated within the group only reach the other members of that group.

If a company wants to create logical workgroups and contain each group's traffic to their respective group, virtual LANs are not necessary. They do, however, offer advantages over alternatives.

Consider what you can do without using virtual LANs. In traditional networks, you can segment at the network layer and use routers to control connectivity. Basically, you can assign users in an IP network to different IP subnets based on logical rather than physical groupings. In that way, two adjacent users on the same physical LAN segment may be members of different subnetworks, and traffic from one to the other must pass through a router even though they are physically "connected."

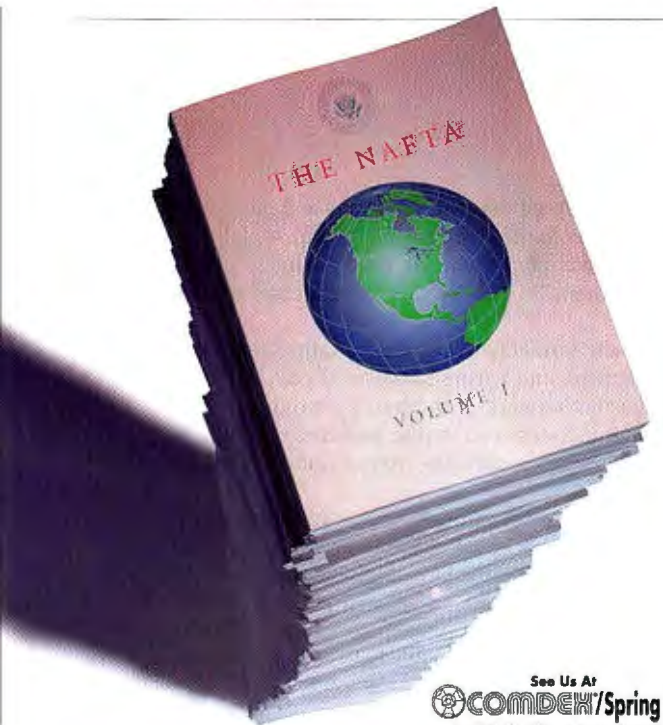
Virtual LANs

PROS	CONS
• Allow quick formation of ad hoc workgroups built around specific projects	• Are mostly proprietary
• Reduce broadcast traffic by limiting traffic to logical workgroups	• Need traditional routed internetworks to handle multiprotocol traffic and mixed networking environments
• Reduce administrative time needed to handle routine, but time-consuming and frequent, user moves, adds, and changes	• Can be overkill in some situations

With virtual LANs, traffic generated for members of one logical group must also get routed to another group to exchange information. So in that sense, virtual LANs and a network where workgroups are synonymous with subnetworks (connected by routers) are similar. However, there are some major differences.

First, with virtual LANs, specific types of connectivity among groups can be simplified by assigning users to more than one group. For example, you may have a number of administratively defined groups (e.g., sales,

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marketing, and product development) where members of each group share resources, such as a CAD program or a shared database. You may also define "global" groups whose members have access to enterprise network resources, such as high-quality printers or an E-mail system.

A second advantage of using virtual LANs instead of interconnected subnetworks is that groups can be formed dynamically. You can easily move people in or out of a workgroup with, essentially, the click of a mouse at a management console.

This capability is handy when forming new groups. It also saves a network administrator much time when handling changes on the network. In traditional networks, configuration changes occur on a regular basis; U.S. businesses annually spend about $1.3 billion moving, adding, and changing users on networks, according to DataPro. Some companies experience more frequent changes than others. For example, in the banking industry, typically, 50 percent to 60 percent of the people change their location each year. With virtual LANs, the changes, as noted, are done at a management station, not by going into a wiring closet.

Companies seeking to cut the administrative costs of handling moves, adds, and changes, as well as reaping other benefits offered by using virtual LANs, will likely choose intelligent switching hubs as the core of their networks.

In the future, as corporate networks incorporate more ATM switching technology, companies will want to retain these same competitive advantages. To that end, the ATM Forum (a group of users and ATM product vendors) is developing a specification for ATM LAN emulation, which lets users create virtual LANs that run over ATM backbone networks. LAN emulation-based virtual LANs will use ATM switched virtual circuits to carry traffic amongst members of administratively defined workgroups.

ATM LAN emulation lets PCs on Ethernet and token-ring LANs connect with other LAN-attached PCs over an ATM network. LAN emulation is basically a way to make the ATM switching transparent to the traditional LANs. In a practical sense, that means workstation adapter cards and their associated driver software does not have to change. Therefore, applications developed to run over drivers, such as NDIS (Network Driver Interface Specification) and ODI (Open Data-Link Interface), can continue to be used.

ATM LAN emulation involves two pieces of management software: LEC (LAN emulation client) and LES (LAN emulation server). The LEC acts as a proxy ATM end station for a LAN workstation and lets LAN clients connect to ATM backbones; the LES resolves LAN MAC (media access control) addresses with ATM addresses. Both pieces of software are required to build high-speed, low-latency virtual LANs based on ATM technology.

Once products that support ATM LAN emulation become available, this should provide a level of interoperability. What that means for corporations deploying virtual LANs is they will no longer be limited to a single vendor's hardware.

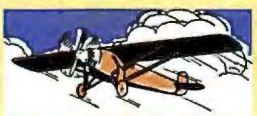
Not a Panacea

Virtual LANs certainly have some good points. There are, however, some shortcomings that users should be aware of before implementing the technology.

The most troubling thing about virtual LAN technology is that it is proprietary. Each hub vendor offers its own management system for defining, creating, and administering a virtual LAN environment. The virtual LAN portion of a hub vendor's management system will not control another vendor's switching

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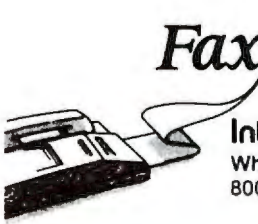
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hub. There is, however, a move toward standardization in the ATM world.

A second shortcoming of virtual LAN technology is that you still need routers to get between mixed networking environments. That's because switching is done at the MAC layer. You would need a router when connecting an IP user to an IPX user or when connecting a user on a token-ring network to another person on an Ethernet LAN.

Another point to consider is that virtual LAN technology may be overkill in certain situations. Sometimes you can meet connectivity requirements using a simpler physical layer switching technology. For instance, a situation may call for the data on multiple LAN segments to be saved to a centrally managed backup system. Or you may have an accounting department that needs access to a high-performance server once a month when the department staffers are balancing the books.

You could handle either situation with a virtual LAN, or you could use the old method of going into the wiring closet and physically connecting the desired server to an appropriate LAN segment. In these examples, the virtual LAN approach is overkill, and the manual approach is too labor-intensive. A better approach would be to use a physical layer switch, such as Switchex from NHC Communications. Physical layer switches that are easier to use than traditional switching hubs operate like electronic patch panels, which you control from a management console.

Obviously, there are many ways to let a group of users share information. Virtual LANs may not be the best solution in all cases. However, in today's rapidly changing business environment where companies must bring together in-house experts on a project-by-project basis, virtual LANs have much to offer. ■

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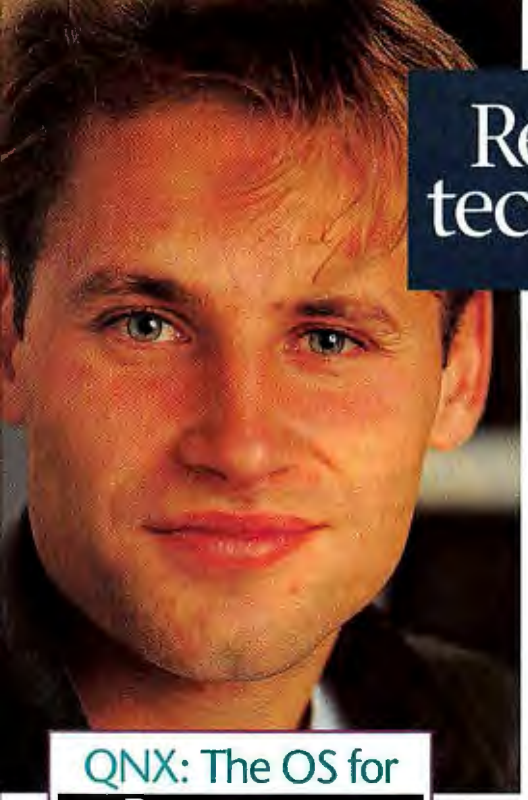
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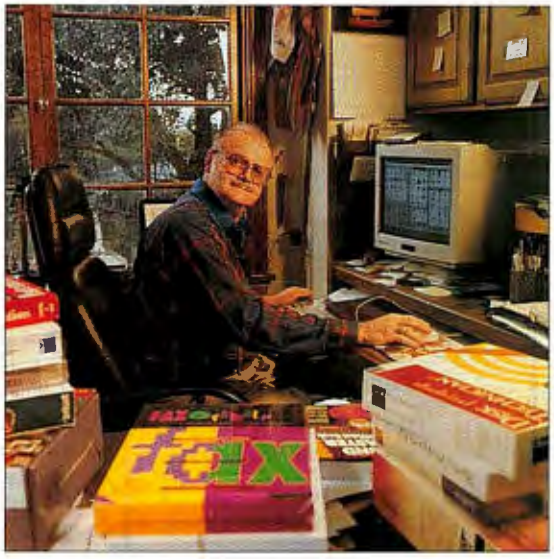
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JERRY POURNELLE

Prizes and Surprises



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Jerry visits Microsoft and finds time to wrestle with OSes, hard drives, and laser printers

I realize I promised more Orchids and Onions this month. However, I am in the midst of gathering information for my upcoming testimony before the House Science and Aeronautics Committee, an effort that has eaten much time... as well as my remaining Orchids and Onions. I apologize if this is a disappointment to anyone; perhaps the information I'll be able to bring back from the committee meetings will make up for it. Stay tuned.

I've just returned from a big shindig in Redmond, where Microsoft was evangelizing the multimedia capabilities of Windows 95. I came away favorably impressed.

It wasn't Windows 95 itself that impressed me. For sheer technical achievement, OS/2 wins over Windows 95. While I haven't done the tests yet—it was only after seeing Windows 95 in action on the Microsoft campus that I decided to fire up my beta-test version here—I have no doubt that on most straight performance benchmarks, OS/2 Warp will turn out to be faster.

What's impressive is Microsoft's determination that Windows 95 will be usable by nearly everyone who buys it for home or office use, and that it will run on just about all the systems customers try it on.

IBM is courting disaster by pushing OS/2 as a home OS. OS/2 can be a great home OS for those who get it running. Once set up, it's stable and reliable, and it can be customized to almost any degree of naïveté or sophistication. You can have buttons for individuals; do that, and they see all and only the programs they will be using. The problem is, even if the installation is simple, OS/2 needs a computer sophisticate to set things up for naive users.

Worse, though, the installation isn't likely to be simple. OS/2 is extremely picky about the hardware it works with. It also demands that you know a lot of the gory details about IRQs (interrupt requests), ports, I/O addresses, and the DMA channels of your sound boards, network cards, and CD-ROM drives.

In contrast, Microsoft is determined that Windows 95 will not only work with 90 percent of what they call "legacy hardware"—what's out there now—but that it will, when possible, recognize potential hardware conflicts and either resolve them or tell you what to do. They know they can't make this 100 percent Plug and Play, but they're trying.

Of course, determination isn't accomplishment. The shipping date for Windows 95 keeps slipping because they've set themselves a difficult goal. That hasn't lessened their determination; moreover, they're not just determined at some corporate executive level. The Windows 95 dog and pony show was put on by working troops—the people who make it happen—and their competence and enthusiasm were obvious.

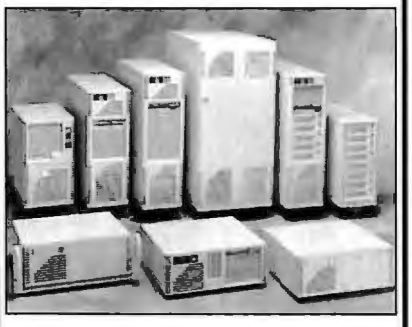
The most common phrase during two days of demonstrations was "making Windows 95 do the right thing" in many situations, from installing a new hard drive to inserting a new CD-ROM to logging on to the Microsoft Network. The goal is for the OS to see what you are trying to accomplish and have a wizard program simplify the work. I don't know if they can bring it off, but I sure congratulate them for trying.

continued

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They've also paid a *lot* of attention to games; it's intended that Windows 95 will run just about every DOS game in existence. IBM wants OS/2 Warp to run DOS games, too, but they have a different approach. Some games hog the entire system, leaving no resources for multitasking. When that happens, OS/2 Warp simply gives up. You're not going to play that game under OS/2 Warp. Windows 95, on the other hand, warns you that you're about to dedicate all your resources to this one game and then lets you go ahead.

When I asked an IBM executive why OS/2 Warp can't work that way, I was told that IBM believes it would be irresponsible to let you devote the entire machine to a single task. OS/2 Warp is a multitasking system. I was puzzled about that, but I needn't have been. It's clear that IBM is more concerned about computers in a corporate and probably networked environment than in a home context. Even at home, you may want to be connected to the Internet, and that wouldn't be possible if you let a DOS game take over your system's resources.

There's another contrast between Microsoft and IBM. As I said before, the Microsoft presentations were done by the people actually working on Windows 95. It's their product, and they're proud of it. The PR people were there, but in the background passing out press releases and briefing books. In an IBM show, it would probably have been the other way around, with the PR people doing the presentation and the technical people hidden in the back of the room—if they were there at all. Oh, well.

I now have OS/2 Warp running quite stably on a ValuePoint Pentium machine. I'll soon have Windows 95 running on a comparable machine. Of course, Windows 95 is still in beta testing, so there are limits to what I can and should report, but I'll try to keep you informed. Meanwhile, though, I'll say this: I'm not often impressed by demonstrations, but I left this one hoping what I'd seen was all true.

My comments on OS/2 Warp don't, or shouldn't, apply to systems on which it's preloaded. Warp remains a better DOS than DOS and, for that matter, mostly a better Windows than Windows once you get everything working properly. On the other hand, we *still* don't have the Creative Labs Sound Blaster Pro working properly in Windows under Warp, although it works fine in OS/2 itself, in DOS under OS/2, in DOS when the system is dual-booted to DOS, and in Windows under DOS.

One of these days, I'll take the trouble to figure out what's wrong; but right now, if I want wave-table sounds, I won't get them in Warp/Windows. So it goes. My point is, if you're buying a machine with OS/2 Warp installed, make sure you buy it with all the hardware you want. Let the dealer worry about making it all work together.

I tend to be pretty cautious about changing OSes, and when MS-DOS 6 first came out, I didn't change over from version 5.0. From reports I've heard, that was just as well.

Recently, Gateway 2000 sent me a new system with MS-DOS 6.22 installed. I studied up on its new features and decided I liked them, and it seems stable enough, so I'm now upgrading my other machines. So far, the process has been entirely painless, and I can recommend that if you haven't upgraded from version 5.0 yet, it's probably time to do so. I particularly like the F5 feature: hold down the F5 key on boot-up, and you get a clean boot with no CONFIG.SYS and AUTOEXEC.BAT. There are other nifty little tricks.

I expect I am way behind the times on this. The rumor is that IBM's latest PC-DOS is DOS died and gone to Heaven. We'll see.

I've had several people, with varying degrees of politeness, tell me that when Microsoft's installation program demands space on the C drive to install something on the D drive, it's not a bug. Windows must write things into the Windows\System directory. One reader got quite indignant that I hadn't figured that out.

I suppose she was right. In my defense, though, I point out that the reason I was installing an upgrade to Microsoft Word 6.0 was that it managed to crash when inputting a file it had created, and I was quite disgusted. Moreover, when there are already 6 MB of free disk space and the installer doesn't tell me how much more it wants, technically that may not be a bug, but it's a pretty odd feature.

The Infocom Memorial Weird Box Award goes to Interplay Productions for Star Reach. The game is an unsuccessful attempt to come up with something as playable as Master of Orion; it's not a bad game, but I'd rather play MOO. However, the Star Reach box is gorgeous. It looks like a spaceship, and it's guaranteed to annoy anyone who tries to display more than one—and drive mad anyone building a pyramid of them....

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isn't a very interesting game. Or it shouldn't be, although I spent more time with it than I'd expected to. Mostly, though, it's important because it was written in Visual Basic and is played from a CD-ROM. The result is a number of interesting visual and sound effects along with table-driven play choices. In theory, it's a game of galactic trade in a rather small—only seven planets—galaxy. Each planet is weird in a different way, and each has an absurd history that isn't meant to be taken seriously.

What is fascinating is just how much they were able to do with Visual Basic and some truly weird artwork that's interesting enough to keep you playing long after you realize you're fighting a random-number generator. There's some kind of pixel replication, because it plays at full-screen no matter what your screen resolution. That's neat, and it sure beats having a tiny little window in the middle of your screen. I suspect it would be a better game against human opponents. Mostly, though, the same techniques can be used to make games in which most of the effort goes into game design rather than programming.

Years ago, I said that small computers would really come into their own when anyone with a good idea could get it running, when knowing how to program wouldn't be as important as thinking of something new and exciting for the machine to do. We're not there yet, but Visual Basic is taking us in that direction.

The Bribe of the Month is a Tyco Hijacker remote-control car from Traveling Software, which they sent to advertise the remote-control capabilities of LapLink for Windows 6.0. I've always had mixed emotions about the value of remote control. The usual procedure at Chaos Manor is to have a parallel cable—one of the yellow ones provided by Traveling Software—on one of the machines in the Windows for Workgroups network. We connect the portable to that. All versions of LapLink—from LapLink 4 on—can access any drive on the network through that connection.

Before a trip, we copy the Franklin Ascend directory to the portable. LapLink is smart enough to copy only the files that have been updated since the last time we did that, so it doesn't waste time recopying the program and help files. Similarly, I mark and copy a whole mess of subdirectories in the Q&A Write and Microsoft Word directories; once again, LapLink copies only what has changed since my last trip. When I get back from a trip, I do the same thing in reverse.

Traveling Software's radio-link system, LapLink Wireless, will do all that automatically and without connecting the parallel cable. I suppose for some people that's a good idea. It's a bit more convenient, and it works. I've just never felt the need. More valuable, to me anyway, is LapLink for Windows, which will let me run programs across the network and, for that matter, through a modem. LapLink for Windows 6.0 is good stuff.

I recently got a new Gateway Color HandBook, a notebook I'm calling SuperCalf. It has two PCMCIA slots but no floppy drive; the only way to install software in it is through the ports. (Actually, there is a neat external 3½-inch floppy drive that attaches, power and all, through the high-speed parallel port. That came in a separate package, so for the first couple of days, the only way to get anything onto SuperCalf was through ports.) It has several ports, including an IR port, and probably came with some kind of communications software; but I'm so used to LapLink that I wanted that. I connected up the blue serial cable and attempted to



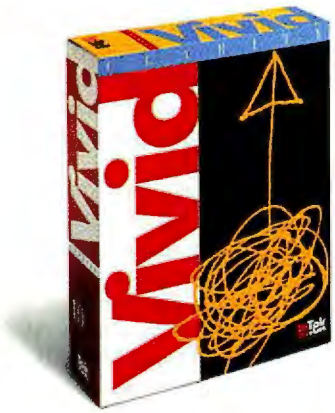
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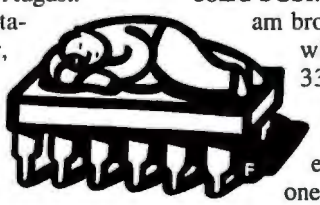
Circle 82 on Inquiry Card (RESELLERS: 83).

send LapLink across to SuperCalf. It didn't work.

I called Traveling Software and got technical support, but in fact, I shouldn't have. SuperCalf comes with MS-DOS 6.22, so all I had to do was the F5 trick. With that clean configuration, it was simple to send LapLink across from Pentafluge to SuperCalf. Moreover, once the full LapLink was running on SuperCalf, I could connect the yellow parallel cable to get things moving faster.

LapLink is seriously good stuff, with or without bribes. Incidentally, I'm astonished that Traveling Software didn't provide an RS-232 interface to the car's control box so I can run it from a laptop....

I've written about Forminco's computer furniture before, most recently last August. I have used Forminco's workstation furniture for over a year, and I have yet to find anything better. It's attractive in a modern sort of way. It's also sturdy—ours survived the big earthquake last year in January—and comfortable. Forminco gets a Chaos Manor User's Choice Award for ergonomic furniture.



Clearing up some confusion: Quarterdeck QEMM 7.5 works, and when QuickBoot works, it works very well indeed; the problem is that it will lock up some machines. Apparently I had a string of bad luck. The first three I used QuickBoot on locked up tight. I've now got it working on others.

QuickBoot is a minor part of QEMM, and I continue to recommend QEMM for those who need memory managers, which is to say everyone who is still using DOS, with or without Windows. The EMM386 .SYS that comes with MS-DOS 6.22 is good, but not as efficient as Quarterdeck's QEMM and Optimize. Another alternative is OS/2 Warp or Windows 95, which get rid of the need for memory managers. I've had mixed experiences with OS/2 Warp. Now I'm experimenting with Windows 95. Stay tuned.

Having said that, let me caution you: if you have QEMM working and upgrade to version 7.5, keep copies of the old version. I recently attempted to convert Pentafluge, our fire-eating Pentium system, to QEMM 7.5. It worked fine with some configurations, but on others, it was simply impossible to run Optimize to completion. I got stuck in what amounted to an endless loop of reboots. The system would bring up the Quarterdeck Identification messages, announce how much memory was available to QEMM—and die. Turning it off would start Optimize over again. Eventually I solved the problem by ditching QEMM 7.5 and going back to version 7.03, which optimizes fine under both MS-DOS 5.0 and 6.22.

By sheer coincidence, the day after that happened, I had a visit from Michael Stout, technical director of Clary. He'd had a Pentium hang up on QEMM 7.5 in just the same way.

The best way to tell a story is to start at the beginning, but I won't go back quite that far, and besides, there are several threads to this.

First thread: we've had at least one Mac since Apple started shipping them. The Mac Plus, about the third revision of the once-unrevisable 128-KB Mac, added onboard SCSI. Shortly after that, Priam brought out the MacDisk, which had an awesome 330 MB of storage at a time when Macs were shipping with 10-MB external drives. We got one of the first of those, and every time we have updated our Mac setup, that Priam drive has come along. It's now on the Quadra, and by gollies, it still works just fine.

Thread two: we got one of the first LaserWriter II printers Apple shipped. Over the years, it was updated until it became a LaserWriter IIg, which was about the last revision Apple made. That was about three years ago, and that printer served us so well that we bought it rather than send it back. However, when we first got Aldus PageMaker 5.0, we had some real problems getting it to work with that old printer, largely because we used the version 8.0 printer driver. Thus, we reverted to PageMaker 4.2, which worked just fine for what we were doing.

A couple of months ago, Apple sent us the new LaserWriter 16/600 PS. It's a 600-dot-per-inch printer (twice the 300 dpi of the LaserWriter IIg). It comes with built-in Ethernet, Windows drivers, a new version of PostScript, and a fax board (although, due to sloth, we haven't installed it). In other words, it's just faster and better and more flexible, and we eagerly installed it and carried the IIg downstairs to use with the Mac in the guest room.

Although the LaserWriter 16/600 PS will work with version 8.0, it really wants the version 8.2 printer driver. Unfortunately, the 8.2 installation program wouldn't work. That might have been because we had a lot of old junk on the Quadra—remember the Priam MacDisk—but we concluded that it wanted System

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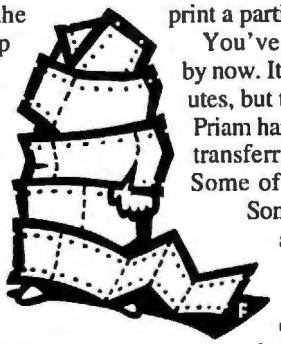
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7.5, which was all right because we'd intended to install System 7.5 anyway.

System 7.5, and then the new printer driver, installed without problems. Then Roberta tried to print some labels that she'd made under PageMaker 4.2. She came down cursing the Ethernet. "It's taking 8 minutes to print one page of labels," she said.

"But we didn't connect it to the Ethernet," I said. When we set up the LaserWriter 16/600 PS, we'd connected it by LocalTalk (the low-speed network that's built into every Mac), and we'd never gotten around to reconnecting it to the Ethernet.



"Well, there's something wrong," Roberta protested, and indeed she was right. LocalTalk is slow and her labels were somewhat complicated, but there was no reason for it to take 8 minutes to print. The problem was we'd changed three things: the printer, the driver, and the OS.

The easiest thing to change back was the printer. We brought up the IIg. It took 8 minutes to print to that, too. Clearly the problem wasn't the new printer.

At this point, we did what we should have done in the first place: we tried printing a couple of test jobs. Those worked just fine, which meant that the real problem was those labels. We looked at them. We also looked at a few other files she had created. One of those couldn't be printed at all. We couldn't even remember the last time a Mac had told us that it couldn't print a particular file.

You've probably figured it out by now. It took us a few more minutes, but then we remembered the Priam hard drive and how we kept transferring files over the years. Some of those files were fonts. Some of those fonts were old and ugly. In particular, Roberta had used some ancient fonts, which required recalculations for changes in size and style. Indeed, the Quadra was doing so much rescaling calculation that it's a wonder it got it all done in only 8 minutes. Changing over to new TrueType fonts took care of the problem entirely. Now the labels print in less than a minute, and on the new 600-dpi printer, they're really pretty. The LaserWriter 16/600 PS is a winner, with enough new features and increased speed to make the upgrade well worthwhile.

We also changed over to PageMaker 5.0. That in itself would have speeded things up considerably, because unlike PageMaker 4.2, version 5.0 does font substitutions, so your computer doesn't have to work so hard at rescaling.

That Priam MacDisk originally came with its own software, but FWB's Hard Disk Toolkit has taken over to make the MacDisk fully compatible with System 7.5 and SCSI Manager 4.3. The latter is the most recent and fastest I/O software for the Mac, and you want to be sure everything you have is compatible with it. Mac software is designed to run with Apple hard drives, and it really doesn't want to be involved with "foreign" drives at all. Fortunately, Hard Disk Toolkit does that job nicely. FWB also makes good caching software for hard drives and CD-ROM drives. If you're contemplating a Mac, you'll want to know about FWB.

You'll also want Connectix's RAM Doubler software. This uses a variety of techniques to create more usable memory

URGENT—YOUR INPUT NEEDED

On: NETWORK DIRECTORY SERVICES

Dear Reader:

To improve BYTE's coverage of technology in the State of the Art section, we'd like to get your feedback about what topics, areas, and products we should be considering, and in what ways. Later this year, we'll be taking a look at network directory services. We're going to examine protocols and services that allow you to locate resources on LANs with multiple servers, on enterprise WANs, and on the Internet. We're thinking about Novell's NetWare Directory Services, Banyan's StreetTalk, and similar services available with other network operating systems and platforms.

So, we want to hear your ideas, to find out about what tools your organization is using and how well they work, about how you manage the problems of naming and multiple servers. Also, we'd like your help in identifying the people we should be talking to about this technology—users, vendors, researchers—you tell us.

To let us know what you think, please use the following as a template to send us, via E-mail, an ASCII text file with your comments. Please be sure to include the <FIELDNAMES> with their angle brackets, followed by your information and comments. And thanks very much for your help.

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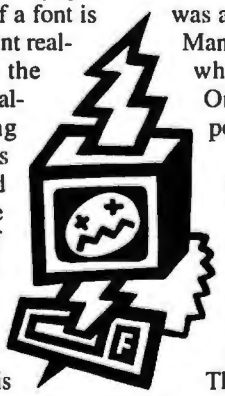
This is where your comments go. Be as brief or as long as you want. Tell us what you think, what you need, what you want to know more about. Tell us what you're doing. Tell us who we should be talking to.

on your Mac. One technique is to make virtual memory on your hard disk, but that's not all RAM Doubler does. RAM Doubler is cheap compared to adding silicon to your system, and we haven't seen anything it doesn't work with. It's easy to install, and if you worry about it, it's not hard to disable. Recommended.

The moral of this story is that being miserly doesn't pay. That Priam MacDisk made it so easy to keep all our fonts that we never threw any away; and that's not really a good idea.

On the other hand, there's no simple way to determine which fonts are good and which ought to be discarded; or if there is, I certainly don't know of it. There are a few Windows font managers, but I've had reason to distrust every one of them I've tried so far; and I don't know of any at all for the Mac.

However, there is a shareware program for the Mac (there's also a commercial version) called theTypeBook, which will print a partial or complete set of all your fonts. It prints one font per page; on that page will be lines in each style and size available for that font. Given that page, you can determine at a glance if a font is worth keeping; if some sizes print really ugly, it's probably because the computer is having problems scaling it to that size. If you hang around while all this printing is going on, you'll also get a good idea of how long it takes for the computer to do the rescaling of that font. You can then discard all the slow ones unless there's some strong reason for keeping them.



Sorting through all your fonts is a tedious job, but it's well worth doing once every few years. Certainly, if we had done so earlier, this problem wouldn't have occurred for us.

There are a lot of reasons to install System 7.5 on your Mac. The built-in File Find is now every bit as good as the Norton file finder. There are "recent applications" and "recent documents" features that let you remember where you were when you shut down the system last. System 7.5 seems to use less memory than its predecessors.

So far, we haven't seen any reason not to switch to System 7.5.

Do you want to feel the bass deep in your bones? Feel that rush when you chain-saw a monster in Doom? Do you like to listen to good music with your PC?

If so, get Altec-Lansing's ACS300.1 multimedia computer speaker system. The system has three units: two midrange/tweeter speakers, which you place on either side of your monitor, and a large floor-unit woofer. The floor unit also contains the power supply for the system and plugs directly into a wall socket.

The result sounds about as good to me as the Lancer speakers connected to my Technics stereo. When Beavis and Butthead say something over the Altec-Lansing speakers, it sounds like they're in the room with me. More to the point, the Microsoft Home music CD-ROMs—Strauss, Stravinsky, Schumann, Beethoven, all excellent—are able to give their music-appreciation lessons with true fidelity.

Of course, once you get speakers that good, you'll want to look into better sound boards. More on that another time; some good ones are coming out.

About five years ago, a drunk rammed a utility pole and dropped a 16-kilovolt-ampere line across the power feeder lines to my house. The resulting power spike caused light bulbs to explode, destroyed a television set, and killed a computer not connected to a power filter unit. When it was all done, the only light in Chaos Manor was the screen of a Cheetah, which was powered by a Clary OnGuard UPS (uninterruptible power supply).

That UPS continued in use until today. It should have been retired at least a year ago; well, maybe not retired, because the electronics were still good, but one ought to replace the batteries in a UPS every four to five years. We finally did that today.

The UPS business is pretty tough. Most of the competition is on price, because it's pretty hard to compare performance. These things either work or they don't, so what you're after is the lowest-cost unit that's good enough. The problem is that what's good enough under one condition may not be under another. Consequently, I can't pretend to know which UPSes are "best." I can say that the critical machines at Chaos Manor have been protected by Clary's OnGuard units for several years, and I have not regretted it.

A UPS isn't very glamorous. With luck, it will serve out its entire life without ever being needed. Not everyone needs a UPS, although people who run computers without power-spike filters are taking foolish chances. On the other hand, a UPS doesn't cost much. Not only did we survive the Great Power Spike (see my August 1989

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column), but I've more than once worked on deadline right through heavy lightning storms that caused the lights to blink and would certainly have caused my system to reset if the Clary OnGuard UPS hadn't been in the loop.

If your work is worth anything, the first thing you need is a good backup system; by "good," I mean one you'll use. Unless you have a lot different temperament from me, those backup programs that require you to sit there and feed in floppy disks aren't worth a thing, because you won't use them. Better is a good optical drive.

I used to be a WORM enthusiast, and if I were doing a lot of programming, I still would be. A WORM preserves all the different editions of what you're working on, and it has been my experience that you will need a subroutine out of an old source program about 10 minutes after you erase the last copy of that version. The only real problem with WORM is the cost of the storage medium.

A better primary backup system is DAT (digital audiotape) run by a good archive library system like Palindrome's Network Archivist. The advantage of DAT is that you can store all the versions of programs and books that you want, because the tapes cost only about $12 for 2 GB of storage capacity. You can buy new tapes at a good record store—our local Tower Records stays open until midnight.

Once you have installed a backup system, you should think about a UPS. It won't save your bacon as often as a good backup system, but it's pretty cheap insurance. I got started with little computers in CP/M days, and I learned to save early and often; even now, I tend to save after every paragraph or so. My partner Larry Niven, on the other hand, gets so wrapped up in what he's doing that he can write several pages before he remembers to save, which is why I have the machine he uses connected to a Clary OnGuard UPS.

Two kinds of UPS units are available, switching and on-line. The on-line units tend to cost a bit more. I think they're more reliable, and that's the kind I use.

I suppose there are well over a thousand multimedia CD-ROMs coming out this year; the total is certainly enough that no one can review them all. Of the hundred this month, two stand out.

The first is called Firenze, which is the Italian name for the city we call Florence. This is something between a goshwow and a tourist guide. It has both still and Video for Windows pictures of the sights of Florence, with narration in English, Italian, German, or Dutch. The sights are keyed to a good map of the city. The photography is excellent, and the narration is well written and easy to hear. There's musical accompaniment well integrated into the tour.

It's not complete; at least I haven't been able to find any mention of my favorite Florentine idiosyncrasy. During the Renaissance, Florence was threatened by a rival city and appealed to Sir John Hawkwood, the English mercenary who figures in Conan Doyle's *The White Company*. Hawkwood offered to save the city; his fee was a larger-than-life equestrian statue of himself in the Cathedral. Hawkwood saved the city.

The Florentines then got thrifty. Instead of a statue, they had a good artist do a larger-than-life painting of a statue on the Cathedral wall. It's very realistic, and from a distance, you'd think it was a big bronze statue mounted on a large granite base. Hawkwood wasn't happy at the time, but he probably gets more notice now than he would if he were just another statue in a city filled with works by Michelangelo, Benvenuto Cellini, and the other great

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Brad Edwards, LAN Times

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ones. Most of those statues are shown on this CD-ROM.

You get all this for $19.95, which is less than you'd pay for a good picture book. Of course, seeing Florentine scenes may get you wanting to go over there, and that will cost a lot more than $20, even if you stay at the Annalena. It's also slow. Even on SuperCow, a 486DX2/66 with a double-speed CD-ROM drive, changing scenes can take nearly a full minute, but that's the nature of Video for Windows.

We're now using the Firenze CD-ROM with the Corel screen saver that comes with CorelDraw 5.0. It's very fast, so we get a new (randomly chosen) art marvel every few seconds. There are some flaws in the Corel screen saver—it kicks in sometimes when you don't want it to—but when the machine is standing idle, you can use any CD-ROM with BMP files. The Firenze CD-ROM is good under its own software and one of the best as a source of eye candy with the Corel screen saver. Recommended.

The second one doesn't stand out because of the CD-ROM so much as the promotion. Quanta Press, the madmen in Minneapolis who bring us, among other things, the Cow Ouroboros, have put together a very traditional database CD-ROM on Angels, Saints, and Icons. There's a tiny concession to multimedia in that it sometimes plays music while you look at an index or a still picture, and sometimes there's narration, but mostly this is just a text database with illustrations. It's done straight, but because the text is from a time when there was more universal belief in the powers of angels and saints, the effect of the dead-serious narration is just at the edge of high camp.

It provides a good collection of very brief (usually no more than one paragraph) identifications of most major and many obscure saints, and all the known angels. Illustration is spotty: there are paintings of some minor saints, but nothing of a major saint like St. Martin of Tours. There's also a scholarly work (by a Jesuit) on arcana angelicae, with discourses on the various orders (e.g., Cherubim, Thrones, Dominations, Powers, and Archangels).

Promotion for the press edition of this consisted of a box containing the CD-ROM and about 20 items from the children's section of a religious bookstore. Those who went to Catholic schools 50 years ago will remember most of the pictures of guardian angels and suchlike. There are also badges, buttons, and pins. Very nostalgic.

Quanta was one of the very early CD-ROM publishers and produced a number

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MOCK TURTLENECK.
Outer Banks 100% cotton mock turtleneck with 20th Anniversary logo embroidered on left chest. White. Sizes: M-XL. M-BYT 4, L-BYT 5, XL-BYT 6. $25.85.



CERAMIC MUG.
11 oz. ceramic mug with gold bond and 3-color, 2-sided logo. BYT 8. $4.50.



MOUSE PAD.
Hard top mouse pad. 4-color with 20th anniversary logo and tag line and repeating text background. 7.5" x 8.5" x 3/16". BYT 7. $5.25.



SWEATSHIRT.
11 oz. cross grain Lee sweatshirt with 20th Anniversary logo embroidered on left chest, features generous athletic cut and side gussets. 95% cotton, 5% polyester. Ash. Sizes: M-XL. M-BYT 1, L-BYT 2, XL-BYT 3. $31.20.



BALL CAP.
Soft brushed cotton free-form ball cap with adjustable Velcro closure back and 20th Anniversary logo embroidered on front. Black. BYT 11. $14.75.



PARKER VECTOR PEN.
Parker Vector Sport Roller Ball Pen. Black with 3-color BYTE logo repeated on barrel and cap. BYT 10. $6.25.

PARKER PEN.
Parker Insignia ball point pen. Laque black with 3-color BYTE logo on clip emblem. BYT 9. $34.50.



T-SHIRT.
100% Cotton Oneita Power-T. White with 1-color "technology" print on both sides and 4-color 20th anniversary logo on front. Sizes: L-XL. L-BYT 13, XL-BYT 14. $8.00.

COMPUTER TOOL KIT.
Deluxe computer service tool kit in black vinyl zipper case features: 2 nut drivers, 3 prong parts retriever, tweezers, torx driver, IC Extractor, one Phillips and 2 slotted screwdrivers. 1-color 20th Anniversary logo. BYT 12. $20.10.



Ordering: Credit card phone orders: Call 1-800-676-HALO (4256) (in IL, call 708/647-4902). We accept VISA, MasterCard, American Express and Discover. Merchandise in stock will ship within 2-3 business days of receipt. If an item is out of stock, the customer will be notified and given the option to backorder, substitute or cancel the item. Rush orders can be shipped the same day received if the order is placed by 2:00 p.m. CST. Rush orders will incur a $10 additional charge and express freight charges will be billed at cost.

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What's New Hardware

WIRELESS MESSAGING SYSTEM FOR WINDOWS

The PageCard Wireless Messaging System for Windows ($399) includes the PageCard receiver, which is activated on the PageNet nationwide network, and the PageSoft communications software. The system, together with Socket's Wireless Messaging Services, allows mobile computer users located virtually anywhere in the U.S. to receive E-mail, news and schedule updates, and other information.

Wireless Messaging Services (activation price, $19.99; local monthly service charge, $19.95; national monthly service charge, $39.99) provides a 24-hour, toll-free number for activation, fax-forwarding, billing, technical support, and operator-dispatched paging. A follow-me fax service notifies you of received faxes and lets you forward them to any number.



Contact: Socket Communications, Fremont, CA, (800) 552-3300 or (510) 744-2700.

Circle 1321 on Inquiry Card.

100-MHZ PENTIUM SYSTEMS

Micron Computer's (Nampa, ID) P100 Millennia systems (from $3699) have an Intel 100-MHz Pentium processor, a 256-KB Micron SyncBurst cache, and 16 MB of Micron extended data-out memory. Other features include a 1.2-GB enhanced IDE hard drive, a quad-speed CD-ROM drive, a Sound Blaster 16 sound card and speakers, a 15-inch Micron 15FGx color monitor, and Microsoft Office Professional 4.3 on CD-ROM.

Phone: (800) 233-7027 or (208) 465-3434.

Circle 1324 on Inquiry Card.

PLUG AND PLAY WAVE-TABLE SOUND CARD

The NuSound audio adapters for PCs, from Orchid Technology (Fremont, CA), combine wave-table synthesis, 3-D audio, 100 percent games compatibility, and support for the Intel/Microsoft Plug and Play specification. The NuSound PnP adapter ($159) offers 16-bit stereo sound, Panasonic and IDE CD-ROM interfaces, wave-table synthesis with 1 MB of compressed wave-table samples, and 3-D audio enhancement technology. The NuSound CD adapter ($199) adds a 16-bit SCSI-2 Plug and Play interface and a 1-MB wave-table synthesizer, which is upgradable to a 4-MB sample set. The NuSound Studio adapter ($299) adds professional music enhancements, 4 MB of ROM, and downloadable RAM-based wave-table synthesis.

Phone: (800) 767-2443 or (510) 683-0300.

Circle 1329 on Inquiry Card.



KEYBOARD FOR LONG-TERM TYPING ▲

Designed for long-duration typing duties, the Ergo-Master keyboard ($495) features independently adjustable halves that let you position the keyboard for maximum comfort and efficiency. Available from Genovation (Irvine, CA), the Ergo-Master's 84 fully programmable keys let you move key definitions to different locations.

Phone: (800) 822-4333 or (714) 833-3355.

Circle 1337 on Inquiry Card.

REMOTE RADIO-CONTROLLED DATA LOGGER

Using FreeWave wireless spread-spectrum-radio data transceivers to transmit data, the Datataker Transceiver System ($3995) can transmit through floors, walls, and ceilings. With line-of-sight distances of up to 20 miles (and up to 60 miles with the FreeWave units performing as repeaters), the Data Electronics (Irvine, CA) system ensures data integrity via packetization, acknowledgment, and 32-bit CRC error detection. Throughput varies with application.

Phone: (800) 956-4437 or (714) 851-5300.

Circle 1326 on Inquiry Card.

CREATE MPEG PRESENTATIONS

With RealMagic Producer, you can create full-screen, full-motion multimedia presentations and titles. The unit ($3995), from Sigma Designs (Fremont, CA), includes a 32-bit PCI-bus audio/video MPEG encoder board, a frame-accurate videotape-recorder controller, Adobe Premiere editing software, and Caligari trueSpace 3-D animation and graphics software. RealMagic Producer lets you capture and compress video and audio in real time and store the information as AVI-editable MPEG. You can edit the frames with any AVI-compatible video-editing tool.

Phone: (800) 854-8086 or (510) 770-0100.

Circle 1325 on Inquiry Card.

RAIDBANK FOR MACINTOSH

MicroNet Technology (Irvine, CA) offers a high-performance RAID system for Macs. RAIDbank for the Macintosh delivers sustained throughput rates of 6.2 MBps and access times as low as 8 ms. The system supports RAID levels 0, 1, 3, and 5 with as many as six Fast and Wide 7200-rpm modules, ranging from 2 to 4 GB, for a total of 24 GB per RAIDbank in single- or dual-channel configurations. A RAIDbank system with two hot-swappable power supplies costs $2675; drive modules cost from $1795 to $3149.

Phone: (714) 453-6100.

Circle 1330 on Inquiry Card.



GO-ANYWHERE NOTEBOOK ▲

Husky Computers' (Clearwater, FL) rugged Husky FC-486 notebook PC (from $2999) features a curved profile that fits snugly into the crook of your arm and a fully sealed magnesium-alloy case that incorporates screen and keyboard into a single hingeless unit. The 4-pound FC-486 comes with a 25- or 50-MHz 486SLC processor, 2 to 16 MB of RAM, up to 16 MB of flash memory, a backlit transflective VGA display, a QWERTY keyboard, two user-accessible PCMCIA slots, and two internal slots for customization. Options include a numeric coprocessor and a high-performance pen.

Phone: (813) 530-4141.

Circle 1328 on Inquiry Card.

MAC DATAPEN

The Mac version of the I.R.I.S. America (Boca Raton, FL) DataPen ($435), a highlighter-size OCR device, allows you to enter printed or typed text and figures directly into your Mac applications. A Windows version ($399) is also available.

Phone: (800) 447-4744 or (407) 395-7831.

Circle 1331 on Inquiry Card.

ELECTRONIC PERSONAL TOKEN

Telequip's (Hollis, NH) Crypta Plus card is a true electronic personal token, a credit-card-size device containing a secure coprocessor and up to 16 MB of flash memory. Lotus Notes users can store desktop files, ID files, telephone- and address-book files, log-on sequences, passwords, and configuration data on the Crypta Plus card (with 2 MB, $265; with 4 MB, $350).
Phone: (800) 225-0580 or (603) 881-5616.
Circle 1332 on Inquiry Card.

HIGH-PERFORMANCE FAX SERVER

Biscom's (Chelmsford, MA) Faxcom 6000 enables users of LAN desktop systems connected to corporate mainframes to send and receive faxes and allows MIS and LAN administrators to manage fax traffic throughout an organization. A multichannel hardware and software solution, each Faxcom 6000 ($22,495) can support up to 24 fax ports. You can assemble multiple units into a single rack-mountable data communications cabinet and control them with a single system console.
Phone: (508) 250-1800.
Circle 1060 on Inquiry Card.

FIERY XJ COLOR SERVERS

Based on Electronics for Imaging's (San Mateo, CA) Fiery XJ architecture, the Fiery XJ170 and Fiery XJ300 Color Servers (from less than $20,000) link computer networks to digital color copiers from Canon, Kodak, Minolta, Ricoh, and Xerox. For producing business graphics, proposals, and presentations or conceptual color proofs, the Fiery XJ170 supports continuous-tone output at 400 by 400 dpi on 8½- by 11-inch (A4) page sizes and 400 by 200 dpi for larger sizes. For heavy production work loads, the Fiery XJ300 server features continuous-print and rip-while-print features with a four-page buffer; the unit can support continuous-tone 400- by 400-dpi output on 8½ by 11 and 11 by 17 (A3) paper sizes.
Phone: (415) 286-8600.
Circle 1334 on Inquiry Card.



MAC MULTIMEDIA TOUCH MONITOR ▲

The $1610 Mac n' Touch AV-14, a touch monitor for the Mac, combines MicroTouch Systems' (Methuen, MA) touch technology and Apple's AudioVision 14 Display, which integrates high-quality stereo speakers, a microphone, and a high-contrast display. The monitor has a dot pitch of 28 mm, a maximum video resolution of 1024 by 768 pixels, a touchscreen resolution of 1024 by 1024 pixels, and a touchdown speed of 8 to 15 ms. Software controls let you customize the sound input and output.
Phone: (800) 642-7686 or (508) 659-9000.
Circle 1333 on Inquiry Card.

EASY INTERNET CONNECTION

Global Village Communication (Sunnyvale, CA) offers OneWorld Internet, an Internet connectivity package for networked PCs. The package includes an Internet server with an internal 28.8-Kbps (V.34) or ISDN modem connection; GlobalCenter Web, Global Village's proprietary Web browser application; mail gateway software; and cables. The OneWorld Internet package works with your site's QuickMail or Microsoft Mail E-mail system and requires only one dedicated telephone line to give every user on your LAN worldwide E-mail access as well as full interactive connection to the Internet. OneWorld Internet for QuickMail costs $1999.
Phone: (800) 736-4821 or (408) 523-1000.
Circle 1327 on Inquiry Card.

SERVER SHARER

Starview Server Sharer allows you to control up to six PCs or file servers with a single monitor, keyboard, and mouse. The unit incorporates microcontroller-based switching technology to enable switching between CPUs from a keyboard or a front-panel push button. As your requirements grow, you can cascade the units to a maximum configuration of 216 CPUs, according to StarTech Computer Products (London, Ontario, Canada). Two models are available: the SV621 (US$349), a six-port cascadable unit, and the SV421 (US$399), a four-port cascadable unit.
Phone: (519) 438-8529.
Circle 1335 on Inquiry Card.



17-INCH PIVOTING DISPLAYS ▲

Portrait Display Labs (Fremont, CA) offers two 17-inch color multifrequency pivoting displays that combine portrait and landscape views. The Pivot 1700 ($895) provides noninterlaced resolutions of up to 1024 by 768 pixels (768 by 1024 in portrait view) at 76 Hz. The Pivot 1700 Professional ($1195) offers noninterlaced resolutions of 1280 by 1024 (1024 by 1280 in portrait view) for Windows and 1152 by 870 (870 by 1152 in portrait view) on the Mac.
Phone: (510) 249-0444.
Circle 1339 on Inquiry Card.

CONVERT DOCUMENTS INTO EDITABLE TEXT



PaperPort 2.0 for Windows ($399) scans at resolutions of up to 400 dpi, providing better OCR accuracy when scanning documents with small text, such as business cards. The input device accepts paper sizes from 2 to 30 inches. In addition, the device uses the company's paper-driven technology, which automatically zips in documents, compresses, crops, straightens, and trims.

PaperPort has direct links to more than 50 desktop applications, such as OCR, fax, contact management, and document management. When you drag and drop a document onto one of these links, the Auto-Launch feature instantly opens the application and places the PaperPort document within it.

Contact: Visioneer, Palo Alto, CA, (800) 787-7007 or (415) 812-6400.
Circle 1322 on Inquiry Card.

What's New Hardware

TAPE BACKUP AUTOLOADERS

Two AutoLoaders from Aiwa Computer Systems (Boca Raton, FL) automate nightly tape backup operations on network servers supporting NetWare, OS/2, Windows NT, Unix, and Macs. The devices support standard 4mm DAT tapes and can perform automatic insertion, removal, labeling, and rotation of 17 tape cartridges. A SCSI-based AutoLoader, the $6995 Aiwa AL-D210 comes with a single tape drive. The $8995 Aiwa AL-D220 features two tape drives.

Phone: (407) 997-6033.

Circle 1338 on Inquiry Card.



PCMCIA VOICE/FAX MODEM ▲

A voice/fax modem for laptops, notebooks, or subnotebooks with Type II or III PCMCIA slots, the Quicktel 14V14PCM PC Card features V.32bis data transmission and V.42bis data compression and can send data and faxes at 14.4 Kbps. From Logicode Technology (Camarillo, CA), the 14V14PCM ($249) provides automatic tone or pulse dialing, automatic call answering, automatic or manual call-originate or answer capability, automatic answer-tone detection, and automatic detection of dial tone, busy signal, ring signal, and carrier. Voice capabilities include up to 999 individual voice mailboxes, password protection, remote paging, and Intelliselect, which distinguishes among data, fax, and voice transmissions.

Phone: (800) 735-6442 or (805) 388-9000.

Circle 1063 on Inquiry Card.

MINICARTRIDGE DATA PROTECTION

The Conner Peripherals (Costa Mesa, CA) Tape*Stor 1700 floppy interface minicartridge tape drive offers up to 1.7 GB of storage capacity, compatibility with the QIC-3020 and QIC-3010 standards, and read compatibility with the QIC-80 and AccuTrak-250 tape formats. The Tape*Stor 1700 ($429) writes data as quickly as 19 MB per minute and supports floppy controllers that have a data transfer rate of 2 MBps.

Phone: (800) 626-6637 or (714) 641-1230.

Circle 1341 on Inquiry Card.

NETWORK TROUBLE-ALERT SYSTEM

Net-911 ($1495) monitors an unlimited number of network file servers accessible over a LAN. When it detects a problem, it automatically places phone calls to persons who should be notified of specific types of failures. The device, from Fox Network Systems (Rockville, MD), monitors the call and automatically retries until it successfully delivers the message.

Key-View ($2995) allows a remote user to call a site, fix and restart a failed file server, switch to the tape backup unit, restart backup processing, and restart a print server during a single phone call. Net-911 complements Key-View by reliably notifying remote users when a network fails.

Phone: (800) 539-8439 or (301) 921-5995.

Circle 1342 on Inquiry Card.

REBOOT LOCKED-UP SYSTEMS BY REMOTE CONTROL

With the three-outlet TeleBoot TB-250 ($249) and the TB-450 ($449), which has five individually addressable outlets, you can remotely reboot a system via either a telephone or a modem. The U.S.A. Communications (Bohemia, NY) devices automatically restore power approximately 30 seconds after you enter a four-digit, user-settable security code. An audible signal confirms the reboot action.

Phone: (800) 724-5434 or (516) 244-6851.

Circle 1344 on Inquiry Card.

MULTIFUNCTION OPTICAL-DISK JUKEBOXES

Two new optical-disk jukeboxes from Plasmon Data (Milpitas, CA) offer capacities of 26 and 33 GB in a compact desktop design (single-drive systems, $6995; dual-drive systems, $9995). The RF20J-690 incorporates a 1.3-GB MO half-height optical drive with an average seek time of 39 ms. Fully loaded, the 20-platter system can store up to 26 GB of data and images. The RF22J-703 incorporates a 1.5-GB phase-change optical drive with an average seek time of 45 ms. The 22-platter system can store up to 33 GB of data and images. The multifunction systems accept any combination of write-once and erasable media.

Phone: (800) 445-9400 or (408) 956-9400.

Circle 1062 on Inquiry Card.



KEYBOARD-ENHANCED PDA ▲

With Zaurus, Sharp Electronics' (Mahwah, NJ) pocket-size, keyboard-enhanced PDA, you can send and receive E-mail, send faxes, access on-line services, exchange information with local and remote PCs, take notes on an electronic notepad, create maps and drawings, generate documents, and manage your time and information. Zaurus (base unit, $749; with CE-FM4 fax modem, $849) supports Sharp's Digital ASK infrared technology, so you can wirelessly exchange information with infrared-equipped PCs, laptops, and devices such as Newton-based PDAs and Sharp Wizards. With optional infrared adapters, you can also beam information to PCs, Macs, and printers.

Phone: (800) 237-4277 or (201) 529-8200.

Circle 1061 on Inquiry Card.

SCANNING FOR LAPTOPS

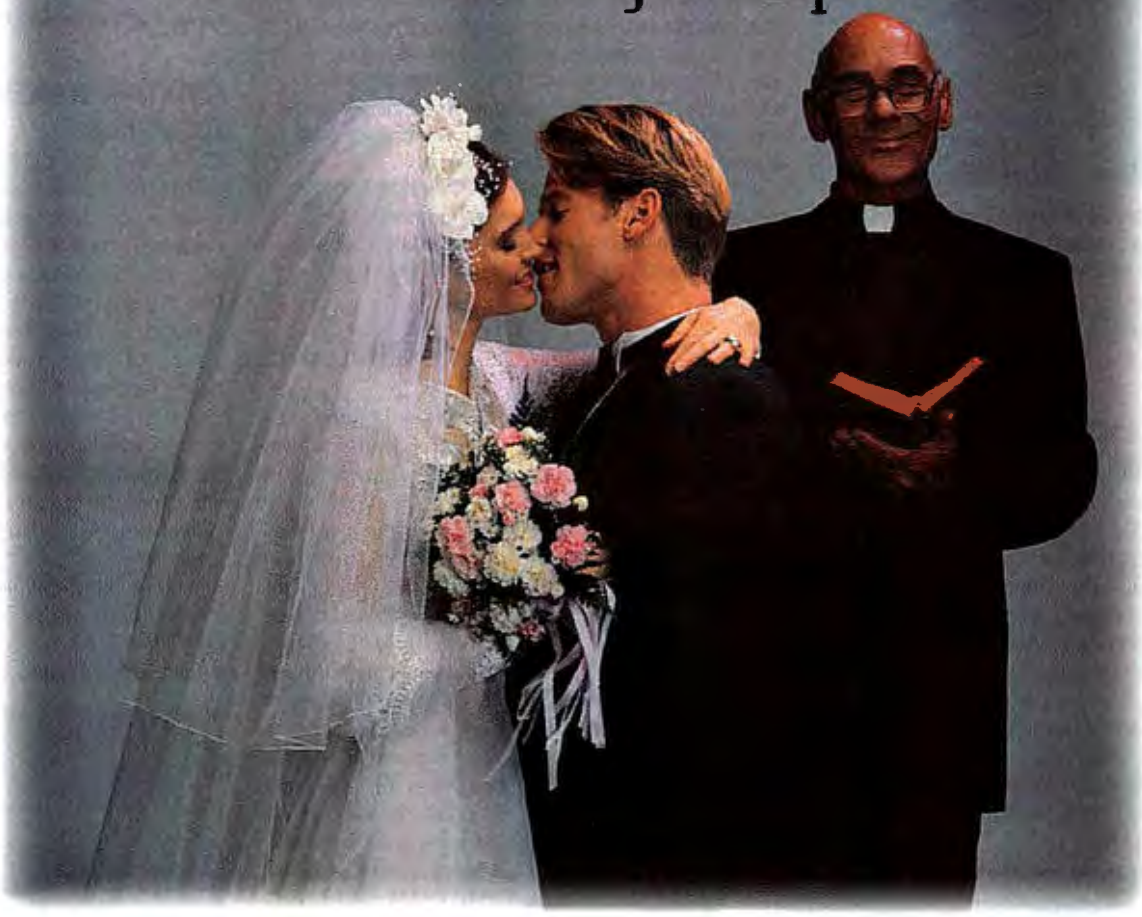


The ColorMobile Office Parallel Color Scanner is a combination handheld/motorized/sheet-fed unit designed for use with laptop and notebook PCs. A snap-on feeder module turns it into a sheet-fed scanner for such items as photographs, business cards, checks, credit cards, and receipts. Attach the motor module, and the ColorMobile Office becomes a motorized, hands-free unit that prevents image distortion by mechanically controlling the scanner's speed as it travels over an image. Components include a trackpad attachment that permits scanning of larger images. The scanner ($329; without sheet-feeding capabilities or trackpad, $249) weighs only 32 ounces with all its components and fits easily into a notebook carrying case.

Contact: Primax Electronics, Campbell, CA, (800) 338-3693 or (408) 364-2800.

Circle 1323 on Inquiry Card.

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The following computer products* have recently earned the NSTL Seal.

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Notebook System

First International Computer Inc.
LEO DESIGNote VP DX4-75
Notebook System

Arima Computer Corp.
NotePro Enhance DX4-100
Notebook System

Clevo Company
7500E DX-33
Notebook System

Clevo Company
7600 P54C-90 Pentium
Notebook System

Dual Enterprises Corp
Dual PMD5000 P54C-90
Pentium Notebook System

Texas Instruments/Racore Computer Products Inc.
Racore M8119 with TI Driver

Allied Telesyn International Corp.
AT 1500 Plus 16-bit Ethernet
AT 1700 Plus 16-bit Ethernet
AT 1720 Plus 16-bit Ethernet

Intel Corp.
Intel EtherExpress PRO with Flash

AT&T GIS
NCR StarLAN 16/4
Token-Ring ISA NAU
NCR StarLAN 16/4
Token-Ring MC NAU

Kingmax Technology, Inc.
PCMCIA Ethernet Adapter EN-10T2

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Circle 92 on Inquiry Card.

What's New Software



FAST, ACCURATE OCR

CharacterEyes for Windows 2.5 ($79.95) uses neural network technology to let you capture text as fast as 300 cps with an accuracy rate of 99.7 percent. The program analyzes page layouts and recognizes text. You can export text directly into word processors, retaining all original text and page attributes, such as point size, tabs, margins, and bold and italic formatting. You can also scan directly from within your favorite Windows applications.

A 32-bit stand-alone program, CharacterEyes Pro for Windows ($495) can read all Western European character sets and offers automatic image rotation, dictionaries for proofing documents, and a trainable mode that lets you teach the software to read obscure typefaces, such as calligraphy, Greek letters, and Gothic fonts.

Contact: Ligature Software, Burlington, MA, (800) 444-6433 or (617) 238-6734.

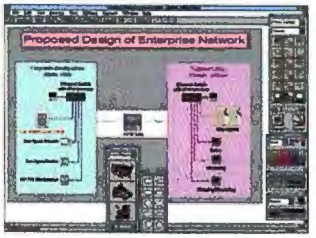
Circle 1065 on Inquiry Card.

WINDOWS-BASED SPEECH RECOGNITION

With OfficeTalk for Windows (US$2045), you can use your voice to dictate, edit, and fax documents. You simply speak into a microphone, and your PC carries out commands and displays your words on the screen. Kolvox Communications' (North York, Ontario, Canada) package includes software, a microphone, and an MWave sound card.

Phone: (800) 556-5869 or (416) 221-2400.

Circle 1068 on Inquiry Card.

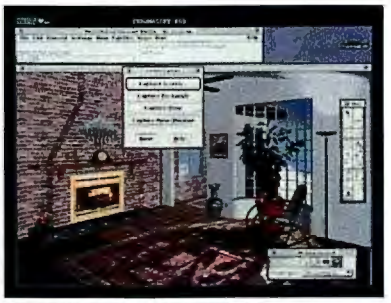


MANAGE YOUR NETWORK ▲

A network diagrammer program based on Windows, ClickNet Professional 2.0 ($795) features more than 2300 network images that you can drag and drop into on-screen diagrams. Behind each diagram, the program, from Pin-Point Software (San Jose, CA), builds an ODBC-compliant database on each network component. You can then produce management reports about specific categories or combinations of categories.

Phone: (800) 599-3200 or (408) 997-6900.

Circle 1069 on Inquiry Card.



MICROSTATION FOR THE ▲ POWER MAC

The Power Mac version of Bentley Systems' (Exton, PA) MicroStation V5 supports the Macintosh user interface, high print resolutions, and most video output, including monochrome and 4-, 8-, 16-, and 32-bit color. MicroStation V5 for the Power Mac ($3950) supports MicroStation DGN file formats and can read and write files in DWG, DXF, CGM, and IGES formats.

Phone: (800) 778-4274 or (610) 458-5000.

Circle 1072 on Inquiry Card.

CREATE MISSION-SCALABLE APPLICATIONS

Digitalk's (Santa Ana, CA) Visual Smalltalk 3.0 ($1495) and Visual Smalltalk Enterprise 3.0 ($4995) feature source and binary portability between Windows and OS/2, a new binary format, improved memory management tools, and support for IBM'S SOM/DSOM. Visual Smalltalk Enterprise 3.0 adds configuration management through the clustering of packages, improved browsers and version-control tools, OS/2 browsers for the SOM Interface Repository and the automatic building of wrappers for `typedefs` and SOM/DSOM classes, automated push-button Smalltalk library generation, and the capability to maintain binary components in repositories.

Phone: (800) 922-8255 or (714) 513-3000.

Circle 1139 on Inquiry Card.

CUSTOMER INTERACTION

A suite of seven customer-interaction applications, Target Enterprise (about $1000 per seat) offers a groupware module, database flexibility, hypertext research tools, an E-mail and Internet interface, scalability, and customization capabilities. The Target Systems (Marlborough, MA) package offers customer service; a help desk; and asset, facilities, network, sales-and-marketing-contact, and change management.

Phone: (800) 233-3493 or (508) 460-9206.

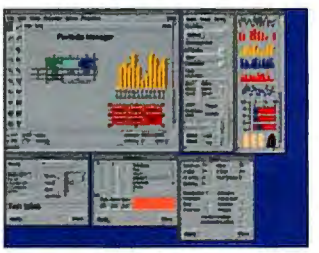
Circle 1071 on Inquiry Card.

APPLICATION MODULES FOR BUSINESS

The Ability for Windows integrated business suite consists of word processing, spreadsheet, database, forms, drawing, charting, and communications modules. When you type in facts, the software ($229) automatically enters information across the board: Change a figure in a document, for instance, and the relevant spreadsheet updates, or the relevant graph redraws. The suite, from Ability Plus Software (Charlotte, NC), also includes import and export filters for popular stand-alone products.

Phone: (800) 946-4277 or (704) 364-3346.

Circle 1131 on Inquiry Card.

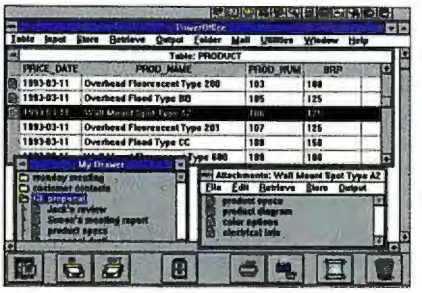


DEVELOP VGUIS ▲

A portable C++ development toolkit, Ilog Views 2.0 unifies graphics and widgets into one tool for designing VGUIs (very graphical user interfaces). Version 2.0 (single development license: Unix, $7500; PC, $5000) lets you increase the amount of information you can display on-screen. It also provides source code for PowerEditor, so you can create, extend, test, and distribute your own GUI builders in C++. PowerEditor's VGUI editor features gadgets, 2-D graphical objects, behaviors, and Ilog (Mountain View, CA) PowerObjects.

Phone: (415) 390-9000.

Circle 1073 on Inquiry Card.



DOCUMENT AND WORK-FLOW MANAGEMENT

A document and work-flow management system, PowerOffice 2.0 ($995 per concurrent user) allows users to store, retrieve, and process such information objects as scanned images, electronic documents, audio clips, and other Windows data types. EZPower Systems' (Philadelphia, PA) package includes multi-engine OCR, full-text, and forms-processing support; revision management; MAPI-compliant mail messaging; and high-volume data-entry modules.

Phone: (215) 496-1700.

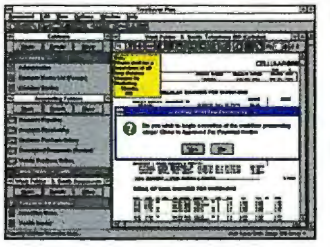
Circle 1132 on Inquiry Card.

VISUAL HELP BUILDER

You can create full-blown help systems with ProtoView Visual Help Builder ($395). With just a few clicks of the mouse, ProtoView Development's (Dayton, NJ) package captures every dialog, menu, and control field of your application and then creates a help system with jumps, indexes, and links. ProtoView Visual Help Builder lets you add color graphics, designate hot-spot regions on a graphic to invoke links to pop-up windows or messages, and, with Microsoft Word's toolbar buttons, place video files and 256-color graphics into your help documents. In addition, you can add voice to pop-ups, hot-spot graphics, and topics.

Phone: (800) 231-8588 or (908) 329-8588.

Circle 1133 on Inquiry Card.



PAPERLESS-OFFICE SYSTEM

TreeSaver Plus, from Micro Telesis (Columbus, OH), is an automated paperless-office system with built-in work-flow processing, document management, and production. Available in single-user ($995) and multiuser ($3495 for five users) versions, TreeSaver Plus automatically routes scanned documents to user-defined electronic filing cabinets and then assigns them to the appropriate user or department for processing or review. When processing is finished, TreeSaver Plus can automatically archive documents with full retrieval capabilities.

Phone: (800) 798-1270 or (614) 798-1234.

Circle 1138 on Inquiry Card.

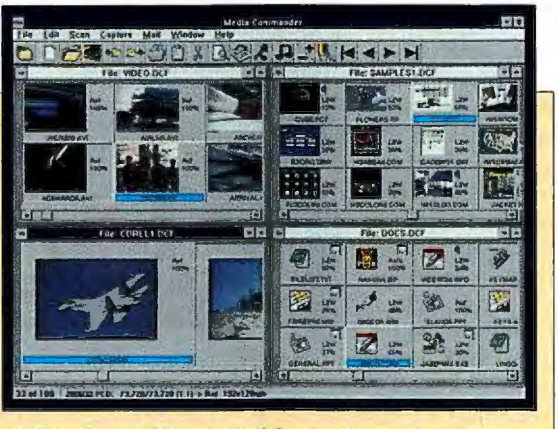
REMOTE CONTROL VIA TCP/IP

Remotely Possible/Sockets (one host and one viewer, from $298) provides TCP/IP support via Windows Sockets for communications across computers, interconnected networks, and various operating systems. From Avalan Technology (Holliston, MA), Remotely Possible/Sockets offers file transfers at a rate of up to 230.4 Kbps over phone lines. Other features include background file transfers while you're running other Windows applications, simultaneous remote printing, two-way communications, remote control via TCP/IP networks and the Internet, and multilevel passwords.

Phone: (800) 441-2281 or (508) 429-6482.

Circle 1135 on Inquiry Card.

MULTIMEDIA MANAGEMENT PROGRAM



With Media Commander for Windows ($129), you can organize all types of media into catalogued thumbnail libraries. The program incorporates images, video, sound, and text and supports more than 70 file formats for import. Video-format support enables you to expand any file to reveal every frame as its own virtual thumbnail. You can also reassemble selected frames to create new videos and export files into various databases.

Contact: DataCal, Chandler, AZ, (800) 223-0123 or (602) 813-3100.

Circle 1137 on Inquiry Card.

Software Update

MKS Source Integrity 7.1, Mortice Kern Systems' (Waterloo, Ontario, Canada) version-control system for software development, includes project management facilities; Visual Merge; new reporting capabilities; "visual differencing," which uses color coding to highlight differences in code; a customizable toolbar; event triggers; a new configuration language; and integration with Visual C++ and Borland C++. US$449.

Phone: (800) 265-2797 or (519) 884-2251.

Circle 1142 on Inquiry Card.

A Windows-based batch scheduler, **AshWin 2.0** offers native support for Alpha, Mips, and PowerPC machines and heterogeneous support for Unix, AS/400, and OS/2 networking environments. Creative Interaction Technologies (Chapel Hill, NC) adds an Enterprise Tree View, a notification feature, Windows NT security and priorities, and remote access. Basic license for five machines and five users, $4950.

Phone: (800) 545-2442 or (919) 419-1694.

Circle 1143 on Inquiry Card.

Imagenation for Macintosh 3.3, Spicer's (Kitchener, Ontario, Canada) document-imaging software, includes such new features as deskew and despeckle; crop and resize; cut, copy, and paste; rubout and erase; a highlighter; bind and unbind objects; multipage TIFF and DCX capability; a measurement tool; saving and reusing of common symbols; support for Micrografx Designer DRW, Intergraph DGN, and AutoCAD DWG; vector-to-raster format conversion; and Apple Event and Apple Script integration. US$1895.

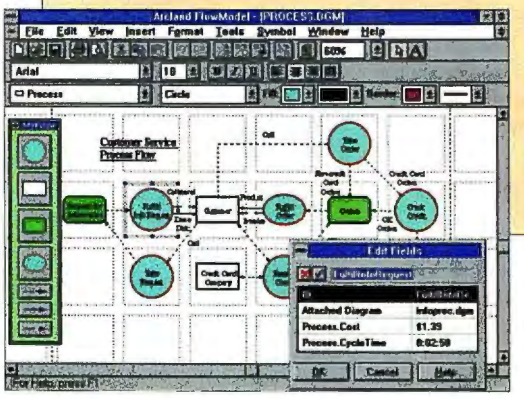
Phone: (519) 748-2462.

Circle 1107 on Inquiry Card.

What's New Software

Analyze Business Processes

If you're involved in business-process reengineering, total quality management, or information-systems analysis and design, then FlowModel ($495) may interest you. The program lets you construct intricate diagrams and flowcharts to analyze areas of inefficiency or to streamline a specific process.



Contact: Arcland, Malvern, PA, (800) 873-2249 or (610) 993-9904.

Circle 1067 on Inquiry Card.

Embedded Development Tools

The TNT Embedded ToolSuite ($2995) delivers a total solution for 32-bit embedded systems development on Intel 386/486 microprocessors, according to Phar Lap Software (Cambridge, MA). Components include the TNT Embedded Kernel; the Visual System Builder; LinkLoc, a 32-bit linker/locator; CVEMB and TDEMB shells for embedded cross-debugging; support for C and C++ run-time libraries; an MS-DOS-compatible file system; a floating-point emulation library; and a remote file system. In addition, you can debug your embedded applications using 32-bit versions of Microsoft's CodeView and Borland's Turbo Debugger.

Phone: (617) 661-1510.

Circle 1136 on Inquiry Card.

NLM for Fax Communications

FaxWare, a 32-bit NLM for Novell NetWare, can send faxes on 64 lines at a rate of 14.4 Kbps while supporting up to 1000 users and 32 servers per LAN. You load the Service Layer of Tobit Software's (Santa Clara, CA) package directly on a network file server, where it becomes a part of the 32-bit NetWare operating system. FaxWare (starter pack for five users and one line, $790) works with Novell's NetWare Connect and NetWare Connect for ISDN and supports multithreading services, IPX communications, queue services, bindery services, and AIO.

Phone: (800) 468-6248 or (408) 982-2562.

Circle 1074 on Inquiry Card.

Natural-Language Translator for Windows

With Transcend, from Intergraph (Huntsville, AL), you can perform quality draft translations of your memos, reports, E-mail, and technical manuals while preserving the original document's format and type specifications. The program allows you to translate from English to Spanish, from Spanish to English, from English to French, or from French to English ($495 per version). Future releases will provide English-to-German, German-to-English, English-to-Italian, and English-to-Portuguese translations.

Phone: (800) 222-9242 or (205) 730-9832.

Circle 1066 on Inquiry Card.

Client/Server Data-Analysis Software

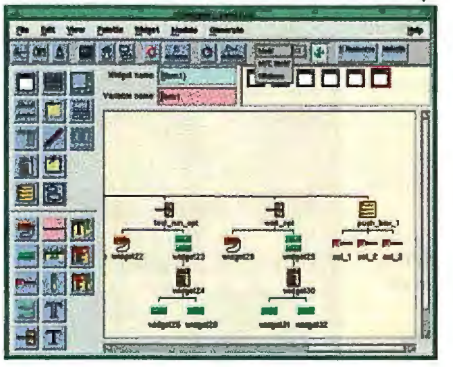
Cornerstone for Windows ($995 per seat) combines the power of statistical software with the familiarity and ease of a spreadsheet program, according to BBN Software Products (Cambridge, MA). The program has the ability to transform megabytes of data into graphical representations, so you can visualize data relationships and then perform numerical analysis.

Phone: (800) 331-2266 or (617) 873-5000.

Circle 1134 on Inquiry Card.

Cross-Platform GUI Builder

X-Designer 4, a cross-platform GUI builder, speeds the development of user interfaces for Motif and Windows applications without relying on proprietary code. Available from DataViews (Northampton, MA), the program has the ability to generate three distinct flavors of C++ code: Motif, Motif MFC, and Windows MFC. X-Designer 4's ($3500) Compound String Editor lets you create strings with multiple fonts and directions. Other features include hypertext help, an advanced layout editor, unlimited undo, the ability to generate C and C++ code, and a range of widgets.



Phone: (800) 732-3200 or (413) 586-4144.

Circle 1140 on Inquiry Card.

Software Update

Leadtools 4.5 lets you add imaging and compression technology to your C, C++, or other applications that provide a C-language interface under DOS, Windows 3.x, Windows NT, Win32s, and Windows 95. Lead Technologies (Charlotte, NC) adds functions to give you more flexibility when using DIBs and DDBs; two types of color reduction; improved performance of 1-bit processing; despeckle; deskew; scale to gray; image-processing functions; and one display and print function to scroll and zoom. From $495.

Phone: (800) 637-4699 or (704) 332-5532.

Circle 1111 on Inquiry Card.

AccuRender 2.1 ray-trace rendering and animation software for AutoCAD releases 12 and 13, from Robert McNeel & Associates (Seattle, WA), provides automatic reflections, refraction, transparency, and shadows; viewpoint animation tools; sunlight animation; 24-million-color output; an on-screen preview feature; a materials library and materials editor; a library of fractal-generated plants; and support for TGA, TIFF, BMP, GIF, and JPEG file formats. $395.

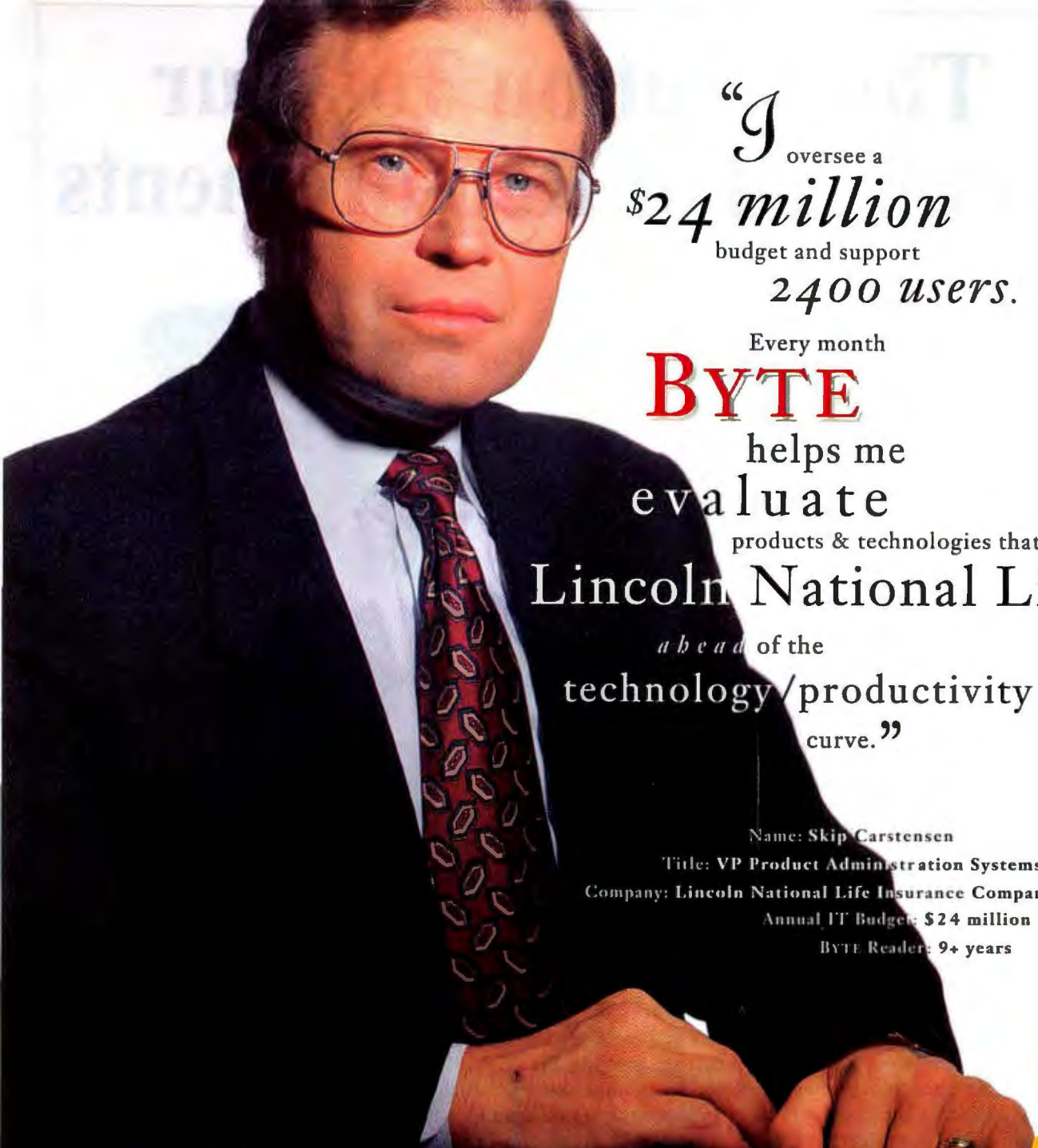
Phone: (206) 545-7000.

Circle 1109 on Inquiry Card.

Bounds-Checker for Windows 2.5, Nu-Mega Technologies (Nashua, NH), delivers automated debugging support for the MFC library and automatic detection of memory leakage, resource leakage, and heap and data corruption in VBXes from C/C++ and Visual Basic. Version 2.5 also automatically checks and validates more than 1700 API calls to the MFC, verifies that parameters on a call are correct, and checks its return status. $249.

Phone: (603) 889-2386.

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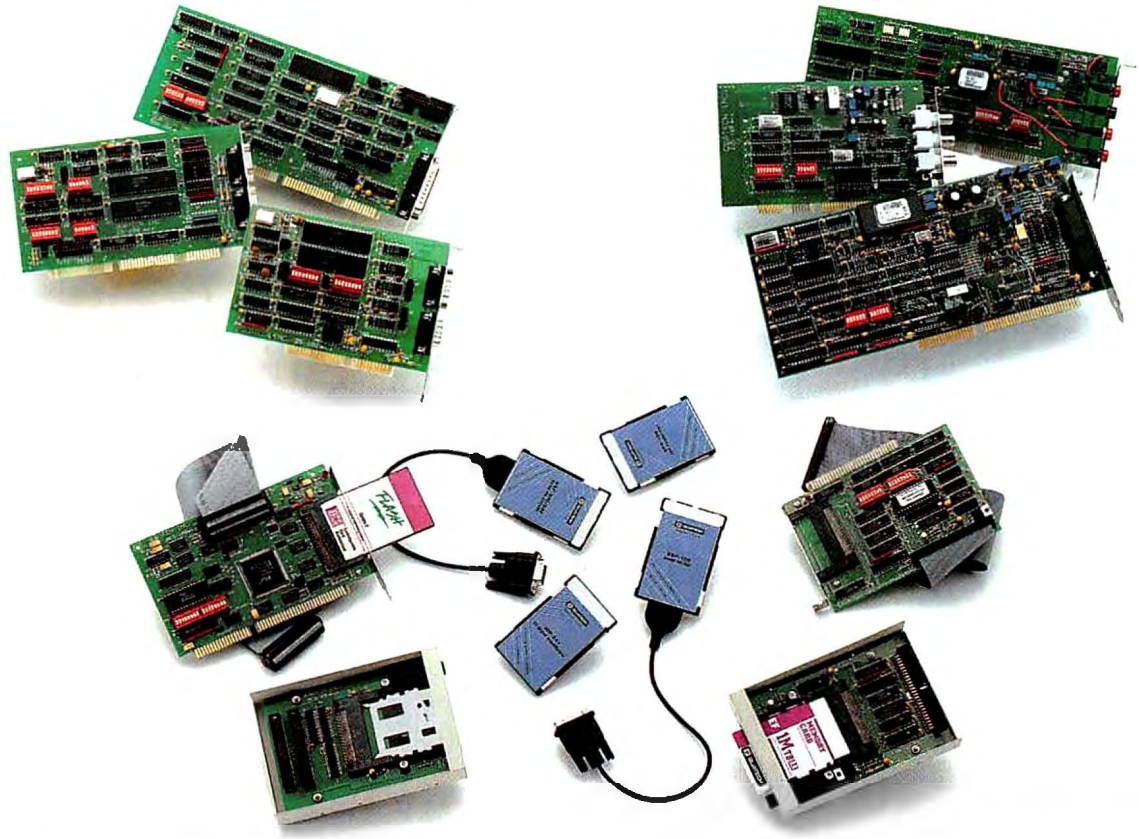
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Sun Moon Star CD 2X kit internal	148.75
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- ▲ 2 Type II or 1 Type III PCMCIA slot
- ▲ Large built-in trackball
- ▲ MS-DOS, Windows 3.1, Tabworks, Lotus Organizer

Display	Hard Drive	Price
9.5" Dual Scan	350MB	$2369
8.4" Active	350MB	2839

Business Lease: $87/mo.

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Texas Instruments
Pentium Power With PCI Bus

TravelMate 5000

NEW TM5000!



- ▲ **16.7 million colors on notebook display!**
- ▲ **Built-in** dual Lithium Ion batteries
- ▲ PCI bus architecture to optimize Pentium processor performance
- ▲ Removable hard drive
- ▲ 2MB Video RAM
- ▲ 16-bit sound, speaker, microphone and MIDI

Processor	Screen	Hard Drive	Price
Pentium 75MHz	10.5" Dual Scan	500MB	$4999
Pentium 75MHz	10.4" Active	772MB	5599

TravelMate 4000M

- ▲ Brilliant color display
- ▲ 16-bit sound card
- ▲ Integrated pointing device
- ▲ 2 Type II or 1 Type III PCMCIA slot

as low as $2119

Processor	Screen	Hard Drive	Price
486DX2/50	9.5" Dual Scan	340MB	$2119
486DX2/50	8.4" Active	455MB	2629
486DX4/75	9.5" Dual Scan	455MB	2799
486DX4/75	8.4" Active	340MB	3069
486DX4/75	8.4" Active	455MB	3319
486DX4/100	9.5" Active	525MB	4279

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ThinkPad® 755CD

- ▲ 8MB RAM expandable to 40MB
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- ▲ 2 Type II or 1 Type III PCMCIA slot
- ▲ 20 popular software titles included!

Processor	Screen	Hard Drive	Price
486DX4/100	10.4" Dual Scan	340MB	$4599
486DX4/100	10.4" Dual Scan	540MB	4949
486DX4/100	10.4" Dual Scan	810MB	5399
486DX4/100	10.4" Active	340MB	5599
486DX4/100	10.4" Active	540MB	5999
486DX4/100	10.4" Active	810MB	6399
486DX4/100	10.4" Active	540MB	7049*
486DX4/100	10.4" Active	810MB	7499*

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ThinkPad® 701 Notebooks
- **Full-sized keyboard**
- **10.4" display**
- **Only 4.5 lbs.**

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Processor	Screen	Hard Drive	Price
486DX2/50	9.5" Dual Scan	340MB	$2699
486DX2/50	9.5" Dual Scan	540MB	3049
486DX2/50	8.4" Active	340MB	3099
486DX2/50	8.4" Active	540MB	3449

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- Built-in AC adapter
- 1 Type II or 1 Type III PCMCIA slot
- MS-DOS, Windows for Workgroups, RunTime Video for Windows, Windows Sound System

Processor	Screen	Hard Drive	Price
486DX4/75	10.4" Dual Scan	500MB	$3639
486DX4/75	10.4" Active	500MB	4749



T2150

10.4" Active Matrix and Dual Scan Displays

Satellite Notebooks and Satellite Pro Series

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- 2 Type II or 1 Type III PCMCIA slot (T2100 series), 1 Type II and 1 Type III PCMCIA slot (T2400 series)
- 82-key keyboard
- MS-DOS, Windows 3.1
- Accupoint pointing device
- Enhanced power management



T2400

	Model	Processor	Screen	Hard Drive	Price
	T2100	486DX2/50	9.5" Mono	250MB	$1439
	T2100	486DX2/50	10.4" Dual Scan	330MB	2249
	T2100	486DX2/50	8.4" Active	330MB	3099
Pro Series	T2400	486DX2/50	9.5" Dual Scan	250MB	2279
Pro Series	T2400	486DX2/50	9.5" Dual Scan	320MB	2449
Pro Series	T2400	486DX2/50	8.4" Active	250MB	2889
Pro Series	T2400	486DX2/50	8.4" Active	320MB	2949
Pro Series	T2450CT	486DX4/75	9.5" Active	320MB	3899
Pro Series	T2450CT	486DX4/75	9.5" Active	500MB	4199

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- Ultra-portability at only 4.4 lbs.
- 8MB RAM expandable to 24MB
- PCMCIA Type II slot
- External 3.5" diskette drive
- Integrated Accupoint pointing device

Processor	Screen	Hard Drive	Price
486DX2/50	8.4" Active	500MB	$3719

T4700, T4800, T4850 & T4900

Sight, Sound & Processing Power

- Brilliant color display with local bus video
- 1 Type II and 1 Type III PCMCIA slot
- Microsoft Sound System, built-in microphone, audio out port
- MS-DOS, Windows for Workgroups 3.11, UltraFont, Indeo video compression software

Model	Processor	Screen	Hard Drive	Price
T4700	486DX2/50	9.5" Active	320MB	$2999
T4800	486DX4/75	9.5" Active	500MB	4189
T4850	486DX4/75	10.4" Active	500MB	4519
T4850	486DX4/75	10.4" Active	772MB	4829
T4900	Pentium 75	10.4" Active	772MB	5499

TOSHIBA

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Versa M and Versa P

- 2 Type II or 1 Type III PCMCIA slot
- Removable hard drive, floppy & screen
- Integrated speaker and microphone
- MS-DOS, Windows 3.1, Windows Sound System, MS Video for Windows Run Time

Processor	Screen	Hard Drive	Price
486DX4/75	9.5" Dual Scan	340MB	$3219
486DX4/75	9.5" Active	540MB	4199
486DX4/75	9.5" High Res.	540MB	4589
486DX4/100	9.5" Active	810MB	5049
Pentium 75	9.5" Active	340MB	4729
Pentium 75	9.5" Active	540MB	5099
Pentium 75	9.5" High Res.	540MB	5479
Pentium 75	9.5" Active	810MB	5599
Pentium 75	9.5" High Res.	810MB	5989

Business Lease: $106/mo.

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Versa P

Versa V

- 4MB expandable to 20MB
- 2 Type II or 1 Type III PCMCIA slot
- Removable hard drive
- Removable floppy – add second battery
- MS-DOS 6.21, Windows 3.1

Processor	Screen	Hard Drive	Price
486DX2/50	9.5" Dual Scan	250MB	$2369
486DX2/50	9.5" Dual Scan	340MB	2499
486DX2/50	9.5" Active	250MB	2889
486DX2/50	9.5" Active	340MB	3029
486DX2/50	9.5" Active	540MB	3399
486DX4/75	9.5" Active	340MB	3399
486DX4/75	9.5" Active	540MB	3779

Business Lease $87/mo.



Versa V

NEC

Hewlett–Packard

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Processor	Screen	Hard Drive	Price
486DX2/50	10.3" Dual Scan	260MB	$2499
486DX2/50	10.3" Dual Scan	340MB	2829
486DX2/50	10.3" Dual Scan	520MB	3199
486DX2/50	10.4" Active	340MB	3769
486DX2/50	10.4" Active	520MB	4129
486DX4/100	10.3" Dual Scan	340MB	3619
486DX4/100	10.3" Dual Scan	520MB	3999
486DX4/100	10.4" Active	340MB	4489
486DX4/100	10.4" Active	520MB	4829



HP OmniBook 4000 Notebook PC

HEWLETT PACKARD

HP OmniBook Notebook PCs 600 Series

Lightweight with Performance

Processor	Screen	Hard Drive	Price
486DX2/50	8.5" Dual Scan	170MB	$2549
486DX2/50	8.5" Dual Scan	260MB	2829
486DX4/75	8.5 Dual Scan	170 MB	3099
486DX4/75	8.5" Dual Scan	260MB	3379

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HP DeskWriter 320	299.99
HP DeskWriter 320 w/Sheet Feeder	359.99
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Seagate

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ST3780A	722MB	12MS	IDE	274
ST31220A	1.05GB	9MS	IDE	389
ST31200N	1.05GB	9MS	SCSI-2	525
ST31230N	1.05GB	9MS	SCSI-2	525
ST11200N	1GB	9MS	SCSI-2	999
ST12400N	2.1GB	9MS	SCSI-2	945
ST32430N	2.1GB	9MS	SCSI-2	945
ST43430N	3.5GB	11MS	SCSI-2	1850
ST15230N	4.2GB	9MS	SCSI-2	1629
ST410800N	9.0GB	11MS	SCSI-2	3069

SCSI-BARRACUDA + 7200 RPM

ST32550N	2.1GB	8MS	SCSI-2	1109
ST151150N	4.2GB	8MS	SCSI-2	2029

Maxtor

FACTORY NEW-2 YEAR WARRANTY

M7420AV	420MB	12MS	IDE	184
M7540AV	540MB	12MS	IDE	211
M7850AV	853MB	12MS	IDE	253
M71260AV	1.2GB	12MS	IDE	389
M73453	345MB	14MS	SCSI	269
MXT540A	540MB	8.5MS	SCSI	345
MXT540S	540MB	8.5MS	SCSI	345
DR341G	165MB	MIL MAX	PCMCIA	360
MobileMax132	131MB	19MS	PCMCIA	375
MobileMax171	171MB	19MS	PCMCIA	445

CONNER

FACTORY NEW-1 YEAR WARRANTY

CFS420A	420MB	13MS	IDE	186
CFS540A	540MB	12MS	IDE	209
CFS850A	850MB	10MS	IDE	269
CNR1275A	1.2GB	10MS	IDE	399
CFP1060S	1.06GB	9MS	SCSI-2	509
CFP21055	2.1GB	9MS	SCSI-2	889
CFP21075	2.1GB	9MS	SCSI-2	1060
CFP42075	4.2GB	9MS	SCSI-2	1869

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FACTORY NEW-5 YEAR WARRANTY

MC2210A	1.05GB	10MS	IDE	$645
MC2217A	1.75GB	10MS	IDE	875
MC2210W	1.05GB	9MS	SCSI-2	650
MC2217	1.75GB	10MS	SCSI-2	875
MC4221	2.05GB	8.5MS	SCSI-2	969
MC3936	3.0GB	13MS	SCSI-2	1399
MC3243	4.3GB	8MS	SCSI-2	1569
MC1991	9.0GB	11MS	SCSI-2	2869
MC4271AV	2.05GB	8.5MS	SCSI-AV	1099
MC1936AV	3.0GB	11MS	SCSI-AV	1545
MC3243AV	4.3GB	8.5MS	SCSI-AV	1689
MC1991AV	9.1GB	10MS	SCSI-AV	3039

FUJITSU

FACTORY NEW-5 YEAR WARRANTY

MD684	535MB	13MS	IDE	$199
M2684S	536MB	13MS	SCSI	274

IBM PS/2

PS/2 50, 50Z, 60, 70, 80, P70, 55SX

200MB	15MS	IDE	$349
429MB	13MS	IDE	369
540MB	12MS	IDE	499
540MB	12MS	SCSI	499
1.2GB	12MS	SCSI	799

MICROCHANNEL CONTROLLER

IDE	16B	SCSI-2	$179

IBM PS/2 INTERNAL DRIVE KITS
30-286,30-286,25-8086, 25-286

210MB		IDE	$299
420MB		IDE	399
540MB		IDE	499
1.0GB		IDE	799

WESTERN DIGITAL

FACTORY NEW-3 YEAR WARRANTY

AC2420	425MB	12MS	IDE	$183
AC2540	540MB	11MS	IDE	209
AC2700	730MB	10MS	IDE	274
AC2850	850MB	10MS	IDE	289
AC31000	1.1GB	10MS	IDE	399
AC31200	1.2GB	10MS	IDE	439

digital

FACTORY NEW-5 YEAR WARRANTY

1.3GB	10MS	SCSI	$694
2.1GB	8.9MS	SCSI	1340

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FACTORY NEW-5 YEAR WARRANTY

1.05GB	10MS	SCSI	$649
2.1GB	8.6MS	SCSI	1029

IBM STANDARD

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94G8512	728MB	12MS	SCSI	350
94G3184	1.0GB	10MS	SCSI	399
70G8492	1.05GB	8.6MS	SCSI	699
70G6493	2.04GB	9.2MS	SCSI	1139
90G7780	2.1GB	8.5MS	SCSI	2139
70G8496	527MB	12MS	IDE	248
70G8498	728MB	12MS	IDE	349
70G8512	1.05GB	8.6MS	IDE	569

Quantum

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MV540A	540MB	11MS	IDE	214
LT540A	541MB	11MS	IDE	232
LM730A	731MB	11MS	IDE	243
LT365S	365MB	11MS	SCSI-2	186
LT540S	540MB	11MS	SCSI-2	243
LM730S	540MB	11MS	SCSI-2	243
MV540S	540MB	11MS	SCSI-2	243
LT541S	541MB	11MS	SCSI-2	243
LM730S	731MB	11MS	SCSI-2	263
IMP1080S	1.08GB	9MS	SCSI-2	540
IMP2210S	2.1GB	9.5MS	SCSI-2	899
LM2150S	2.1GB	8MS	SCSI-2	1109
GP42805	4.2GB	8.6MS	SCSI-2	1925

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MC3243	4.3GB	8.5MS	3.5	2169
MC1991	9.10GB	10MS	FH	3359

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08B4191	2.04GB	8MS	3.5"	1279
08B4453W	4.51GB	7.1MS	FH	2179

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CP1060W	1.06G	10MS	3.5	$799

Seagate

ST31200W	1.05GB	9MS	3.5"	$749
ST12550W	2.13GB	8MS	3.5"	1329
ST15150W	4.29GB	8MS	3.5"	2499

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MC4221	2.05GB	8.5MS	LP3.5	$1729
MC3243	4.3GB	8.5MS	3.5	2169
MC1991	9.10GB	10MS	FH	3359

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MK1824FC	360MB	15MS	IDE	344
MK2426FC	540MB	15MS	IDE	574
MK2528FC	700MB	15MS	IDE	680
MK2428FC	520MB	15MS	SCSI	524

IBM

dhhOHS20	520MB	IDE	699

Seagate

ST9145AC	120MB	16MS		$275
ST9150AC	210MB	16MS		275
ST9235AC	210MB	16MS		275
ST9385AC	340MB	16MS		439
ST9550AC	455MB	16MS		439
ST9655AC	524MB	16MS		529

Quantum

GLS250AT	256MB	17MS		$295
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8200	2.5GB TAPE INT/EXT	1,379/1,679
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486DX4-75	573	386DX-40	545
486DX4-100	673	486DX2-66	195
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PENTIUM 60	598	486DX2-80	225
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		486DX-33	$100
		486DX-40	100
		486DX2-50	100
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80387-2 MHZ	138	80387SX-20 20MHZ	75	83SX87SX-25 25MHZ	75	83D87-20 20MHZ	50
80387-16MHZ	0	80387SX-16 16MHZ	75	83D87SX-33 33MHZ	75	83D87-25 25MHZ	50
80387-20 MHZ	46	80387SX-20 20MHZ	75	80647SX-25	345	83D87-33 33MHZ	50
80387-25 MHZ	50	80387SX-25 25MHZ	75			83D87SX-40 40MHZ	50

83SX87SX-25 25MHZ	50	83D87-33 33MHZ	50
83SX87SX-33 33MHZ	50	83D87SX-40 40MHZ	50
83SX87SX-40 40MHZ	50	83D87-40 40MHZ	50
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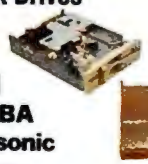


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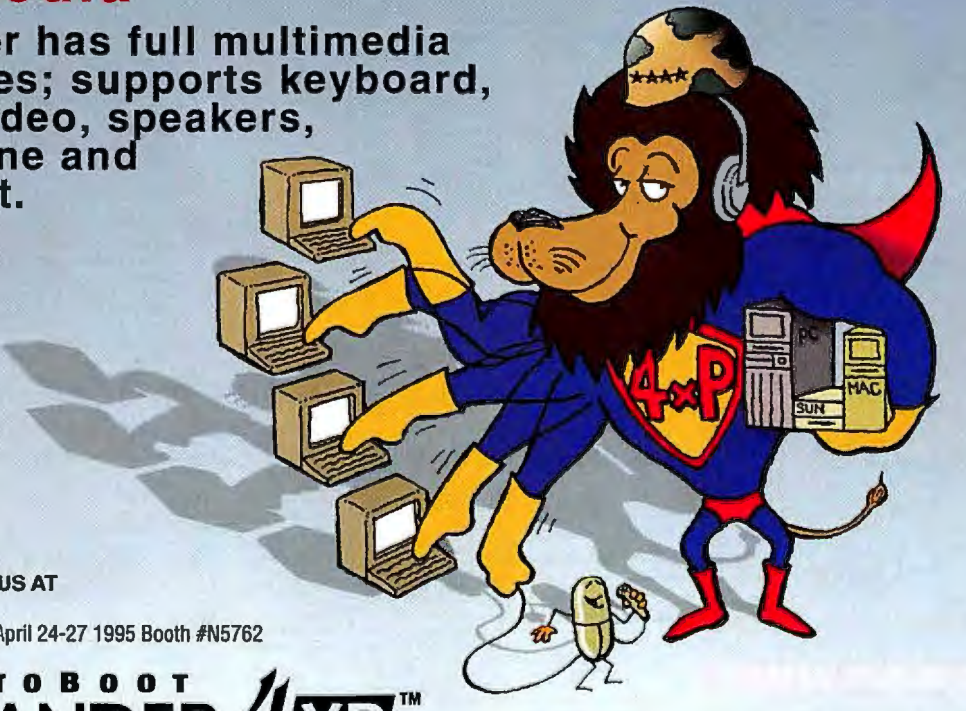
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	4MB	07G1827	$188
	8MB	07G1828	$418
Laptop N33SX, L40SX & PS/NOTE 182	2MB	79F0999	$98
	4MB	79F1000	$184
L40SX, PS/NOTE 182 ONLY	8MB	79F1001	$358

AST COMPUTER

MEMORY

MODEL#	MEMORY	PART#	PRICE
PREMMIA	4MB	501159-001	$188
	8MB	501159-002	$366
	16MB	501159-003	$760
ADVANTAGE 386SX/20-25, PRO SX/25 BRAVO 3/33'S	2MB	500962-001	$88
	8MB	500962-002	$348
BRAVO N8486	4MB		$198
	16MB		$798
ADVANTAGE PRO 486DX/33:SX/25, BRAVO LC 4/ 25S, 33, 33S, 50D; 466D	2MB	500987-001	$88
	4MB	500987-002	$164
	16MB	500987-004	$578
PREMIUM 386/25; 33; 33T II 386SX/16:20:25	1MB	500780-003	$48
	1MB	500780-002	$48
ADVANTAGE 486/25; 33;33P;SX20, BRAVO 4/33; 486/ 25; PREMUM 4/25; 33TE, SE 4/332MB50DT/8-004	8MB	500780-004	$68
	2MB	500780-005	$68
ADVANTAGE 486/25;33;33P;SX20,POWER PREMIUM 3/33,4 33; 33S; 50D;66D; PREMUM 386/33TE, 486/25;E; 25TE; 33; 33TE; PREMUM II 386/25; 33, 486/33, 486SX/ 20PREMIUM SERVER SE 4/33	4MB	500780-004	$178
	8MB	500780-001	$348

AST LAPTOP

POWER EXEC 3/25SL, 3/25SL C.EL	4MB	$178
	16MB	$768
POWER EXEC 4/25SL/33SL	4MB	$178
	16MB	$688
PREMIUM EXEC 286,386SX/20;25;25C	4MB	$178
BRAVO NB486	4MB	$188
	16MB	$668
ASCENTIA 900N, 800N 4133-50-75	4MB	$198

NO RETAIL WILL CALLS ONLY

COMPAQ

Compaq Memory

MODEL	MEMORY	PART#	PRICE
Deskpro 286E; 386-20; 20E; 25; 25E			
	1MB	113131-001	$59
	4MB	113132-001	$188
Deskpro 386S	4MB Board	113634-001	$254
	4MB Module	112534-001	$188
Deskpro 386-20E; 25E	4MB	113645-001	$238
Deskpro 386/33/33I; 486/25; 33I;50L; Systempro	2MB	115144-001	$108
	8MB	116561-001	$378
	32MB	116568-001	$1458
Systempro; Deskpro	6 SKT EXP BRD W/2MB	116569-001	$268
Compaq "M"	2-64MB	129160-001	$188
Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M , Systempro LT Series 129160-001, Pro			
Signia	1MB	118688-001	$49
	2MB	118689-001	$84
	4MB	118690-001	$168
	8MB	128877-001	$348
Prolina 3/25 & 25Z	2MB	141738-001	$88
	8MB	141742-001	$318
Prolina 4/25si, 4/33, 4/502MB Module		141683-001	$94
	4MB Module	141684-001	$178
	8MB Module	141685-001	$338
Compaq Pro Signia	16MB	149320-001	$684
	32MB	149147-001	$1524
DeskPro 5/60, 5/66M	8MB	149911-001	$389
Prosignia PC Server, 486/33/66	8MB	141685-001	$348
	16MB	149320-001	$648
	32MB	149147-001	$1498
Prosignia 5/60	16MB	149949-001	$698
Proliant 100 5/60	32MB	149912-001	$1398
Proliant 2000 4/30, 5/66	64MB	149913-001	$2698
Proliant 4000 4/50, 5/66	128MB	149914-001	$5600

Compaq Laptop & Notebook

Concerto 486	4MB		$188
	8MB		$358
	16MB		$698
Contura 320, 325, C	2MB	139497-001	$98
	4MB	139498-001	$174
	8MB	139499-001	$318
Contura 4/25CX	4MB	146520-001	$178
	8MB	146521-001	$338
	16MB	146532-001	$718
SLT/286	1MB	110235-001	$75
	4MB	110237-001	$218
SLT386	1MB	118303-001	$79
	2MB	118304-001	$108
	4MB	118305-001	$198
Lte 286	1MB	117081-001	$79
	2MB	117081-002	$99
	4MB	117081-004	$178
Lte 386S/20	1MB	121125-001	$98
	4MB	121125-002	$208
Lte Lite/20, 25, 25C	2MB	129769-001	$138
	4MB	129769-002	$208
	8MB	129769-003	$388
	16MB	129769-004	$808
LTE Lite 486/25C	4MB	142337-002	$178
	8MB	142337-003	$348
	16MB	142337-004	$718
Aero 3.3volt	4MB	190532-001	$188
	8MB	190597-001	$358

Laser Printer Memory

MODULE	1MB	2MB	3MB	4MB	5MB	8MB
Canon LBP4, 4 Lite & 4+	$118	$164				
Canon LBP-430	$128		$228			
Epson Action Laser II, 8000	$86		$198		$268	
Epson + 6000 and many more	$128		$198			
Epson Action Laser 1000 & 1500	$98		$188		$399	
Fujitsu 7100 & 7200	$199	$279				
HP Deskjet 500, 500C, 510, 550C and 560	$38 (256K)					
HP 2, 2D	$98		$164			
HP 3, 3D, 3P, 2P, 2P+	$98		$168			
HP Laser Jet 4, 3Si, XL300, 1200C		$84		$168		$318
IBM Laser 4019, 4019E (3.5MB)	$114		$164			
IBM Laser 4029	$95		$155			
NEC 90, 290	$104					
NEC 95	$88					
OKI 400&68	$88					
Packard Bell PB9500	$125		$208			
Panasonic 4410/4430	$118		$174			
Panasonic 4420/4450	$118		$178			
Panasonic 445O	$98					
Panasonic 4400/5400	$129		$198			
QMS 410	$119	$159		$249		
Toshiba Page Laser 6	$99		$168			
TI XL/PS17/PS35	$44	$98				

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TOSHIBA

Toshiba Memory

MODEL	MEMORY	PART#	PRICE
T1000 SE/LE/XE	1MB	PA8311U	$29
T1000 SE/LE/XE	2MB	PA8312U	$73
T2000 / T2000SX	2MB	PA8317U	$73
T2000SX/T1000 LE	4MB	PA8314U	$188
	8MB	PA8315U	$358
T1200 XE	2MB	PA8306U	$98
T1600	2MB	PA8302U	$98
T2000 SXE/T2200SX/T1800 T1850, C	2MB	PA2000U	$78
	4MB	PA2001U	$198
	8MB	PA2002U	$358
T2400, T2450, T3600 3.3V	4MB	PA2019U	$218
	8MB	PA2020U	$398
	16MB	PA2023U	$798
T3100	2MB	PA7135E	$138
T3100 E	2MB	PA8341U	$108
T3100 SX	2MB	PA8308U	$108
	4MB	PA8310U	$188
T3200 SX	2MB	PA8307U	$118
	4MB	PA8309U	$198
T3200 SXC	2MB	PA8318U	$108
	4MB	PA8319U	$198
T3200	3MB	PA7137U	$184
T3300SL	2MB	PA2006U	$118
	4MB	PA2007U	$238
	6MB	PA2008U	$258
	16MB	PA2009U	$698
T3400CT	4MB	PA2019V	$218
	8MB	PA2020V	$399
	16MB	PA2021V	$758
T4400 SX, SXC, T6400 SXC, DXC	2MB	PA2003U	$125
	4MB	PA2004U	$198
	8MB	PA2005U	$358
	16MB	PA2010U	$698
	32MB		$1548
T4500, T4600, T1900C (3.3VOLTS) T4700	4MB	PA2012U	$198
	8MB	PA2013U	$388
	16MB	PA2014U	$858
T5100	2MB	PA8301U	$94
T5200/T5200C/T8500/T5400	2MB	PA8304U	$109
	8MB	PA8313U	$418

*FREE TOSHIBA MODEM W/ TOSHIBA MEMORY PURCHASE!

MAJOR LAPTOP & NOTEBOOK MEMORY

MODEL	MEMORY	PART#	PRICE
Acer Note (All models)	4MB		$238
	8MB		$438
Apple (Call)			
Canon Notejet 486	4MB		$238
All series	8MB		$418
Dell 320N, 212N	2MB		$98
NL25, NL20			
Dell Latitude	4MB		$198
	16MB		$698
Dec Notebook 425/433	4MB		$198
	16MB		$798
Epson Action Note	2MB		$122
	4MB		$218
Everex Tempo LX, LX20	2MB	00160	$98
Gateway 2000	4MB		$188
	16MB		$1475
Gateway 2000 486	4MB		$188
	16MB		$781
HP Omnibook	2MB		$96
	4MB		$208
Packard Bell, Magnavox, Minuka	1MB	N/A	$108
	4MB	N/A	$198
Panasonic CF170/270/370	1MB	CF-BA165	$64
Panasonic CF380, Y2IP, V4I	4MB		$218
	16MB		$896
Sanyo 17NB, 18NB & ZEOS	2MB	MBC-NBMEM2	$98
SHARP PC-7700, 7750	4MB		$198
8150, 8650, 8660	16MB		$498
SHARP PC8501	2MB		$108
TI Travelmate 2000	1MB	2568034-0011	$88
TI Travelmate 3000SX, WINSX	2MB	2566996-0001	$94
TI Travelmate 4000, WINDX/25 SX/16, SX25, DX2/50, DX2/40	4MB	2581265-001	$188
	16MB	AVAILABLE	$1298

CACHE MEMORY

	12ns	15ns	20ns	25ns
8KX8		5.95	5.75	5.45
32K8	12.00	8.95	7.75	6.95
64x1		10.95	7.05	6.95
64x4		10.00	7.95	6.95
16x4		6.95	6.45	5.95
128x8		54.00	34.00	27.00

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AST

Premmia GX P/100, P/90
8MB 501565-001 ....$309 16MB 501566-001 ....$609
32MB 501567-001 ....$1,007 64MB 501568-001 ....$1,999
Premmia MTE, SE P/60
4MB 501159-001 ....$190 8MB 501159-002 ....$357
16MB 501159-003 ....$712 32MB 501159-004 ....$1220
Bravo 586 SX WS/286, 386
2MB 500510-002 ....$88 4MB 500510-008 ....$195
Bravo 3/25s
2MB 500710-004 ....$89 8MB 500824-002 ....$304
Advantage! Plus 486DX/33, DX2-50, DX2 66
4MB 501168-001 ....$158 8MB 500824-001 ....$306
Advantage! and Advantage! Pro 386SX/20, 25, Bravo 3/33s
2MB 500962-001 ....$80 8MB 500962-002 ....$272
Advantage! Pro 486DX/33, SX/25
Bravo LC, LC II, LP and MT
2MB 500987-001 ....$86 4MB 500987-002 ....$151
16MB 500987-004 ....$518 32MB 500987-005 ....$1089
Premium 386/25, 33, 33T and Premium II 386SX/16, 20, 25
1MB 500780-003; 002 ....$45
Premium 386/33T, 386SX/16 and Premium II 386SX/20, 25
4MB 500780-004 ....$188
Advantage! 486/25, 33; 33p, SX20, Premium Server SE 4/33
Power Premium and Premium TE all models
Premium II 386/25, 33, 486/33, 4x66SV/20
8MB 500780-001 ....$298

COMPAQ

Presario 500, 700 and 900 series
4MB 147522-001 ....$159 8MB 147523-001 ....$307
16MB 147524-001 ....$544 32MB 147525-001 ....$1019
ProLinea 2000 and 4000 series, Systempro XL
16MB 149949-001 ....$709 32MB 149912-001 ....$1426
64MB 149913-001 ....$2456 128M 149914-001 ....$4595
ProLinea 3/25s, 3/25sn
2MB 141738-001 ....$89 8MB 141742-001 ....$304
Presario 600 and 800 series, ProLinea 4/25, 4/33, 4/50, 4/66
ProLinea MT and ProLinea Enhanced series, ProSignia VS
4MB 141684-001 ....$153
8MB 141685-001 ....$307

HEWLETT-PACKARD

Vectra VL2, XP, XU, M2, N2 and XM2 models
Netserver LM, LC and LF models
4MB D2974A ....$179 8MB D2975A $356
16MB D2297A ....$609 32MB D2298A $1152
Vectra QS and RS models
4MB D1542 or 1642A $177
Vectra 486 M, ML, N, NI and XM models
2MB D2581A ....$95 8MB D2152A $305
4MB D2156A ....$151 16MB D2676A $611
Vectra 386/25, 486/25U, 33U, 33ST, 50U 66U and 66ST
2MB D2581A ....$95 8MB D2152A $357
Vectra 386/33N, NI models
2MB D2714A ....$92 8MB D2715A $304

IBM

Aptiva 300, 500 and 700 series
4MB n/a ....$159 16MB n/a $509
Eduquest 55
4MB 74G1399 ....$174
Eduquest 30 , 40 and 50 models
4MB 60G0896 ....$174 16MB 60G0898 ....$349
PS/1 286, 386SX
2MB 92F9935 ....$83 4MB 92F9694 ....$163
PS/1 Consultant, Essential, Expert models x43, x44,
PS/Valuepoint all models except Cxx models
4MB 96F9290 ....$177
16MB 96F9291 ....$609
PS/1 Consultant, Essential, Expert models
16MB 96F9291 ....$609
PS/2 25/286, 30/286
2MB 30F5360 ....$79
PS/2 35SX, LS, 40SX, 90, 55SX, LS, 65SX, LS, 70, XStation
2MB 6450604 ....$87
PS/2 70-A21, A61, B21, B61, PS/Valuepoint Cxx models
PS/1 Consultant, Essential, Expert models
2MB 6450608 ....$95
PS/2 35SX, LS, 40SX, 55SX, LS, 65SX, LS, XStation,
PS/Valuepoint Cxx models
4MB 54F2933 or 87F9977 ....$179
PS/2 55SX, LS, 40SX, PS/Valuepoint
8MB 6450129 ....$356
PS/2 90 XP, 95 XP, P75 (pairs) 56, 57 (all) PS/1 Pro M2123
2MB 6450902 ....$85
PS/2 90 XP, 95 XP, P75 (pairs) 56, 57 (all models)
PS/1 Consultant, Essential, Expert models, PS/1 Pro M2123
4MB 6450128 ....$169 8MB 6450150 ....$356
PS/2 80-111, 311, L21, 521, 081, 161
2MB 6450579 ....$88
PS/2 80-A21; A31; A16
4MB 6451060 ....$193
Expansion boards for PS/2 80286 based models
4-16MB w/4MB 6450609 (use 72-pin) $299
Expansion boards for PS/2 80386 based models
2-14MB w/2MB 34F3077 ....$205
4-16MB w/4MB 34F3011 ....$299

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30-PIN	72-PIN
1 x 3-70ns (3-chip/1MB) $35.[99]	512 x 36-70ns (2MB) $92
1 x 9-70ns (1MB) $37	1 x 36-70ns (4MB) $140
4 x 9-70ns (4MB) $126	2 x 36-70ns (8MB) $292
16 x 9-70ns (16MB) $565	4 x 36-70ns (16MB) $519

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DELL

Optiplex ME and V models, PowerEdge XE models
Performance L, M and T models
4MB 310-3325 ....$151 16MB 310-3327 ....$525
Power Desktop and Low Profile Power Desktop models
1MB 310-2505 ....$49 4MB 310-2507 ....$151
16MB 310-2625 ....$575
PowerLine Workstation DE and SE models
2MB 310-2466 ....$99 4MB 310-2467 ....$190
8MB 310-2468 ....$357 16MB 310-2469 ....$712
Performance ME models
8MB 310-3335 ....$305 32MB 310-3337 ....$1220

ZENITH

Z-400+, Z-Station SEb, SEp, Sh, Se, DEb, Dh and Xeri
Z-300/400 Series, Z-420/SE, Z-425/SX, Z-433/DX, SX
4MB ME-100 ....$179 16MB ME-90 ....$610

NEC

Image 425, 433, 466
4MB 410-12002 ....$147 16MB 410-12005 ....$556
Ready 425, 433
4MB n/a ....$147 16MB n/a $556
PowerMate 386/33L Express Te e models
4MB OP410-6205 ....$176 16MB OP410-6206 ....$610
PowerMate SX Plus
2MB Board n/a ....$163 4MB Board n/a $278
PowerMate SX/20
2MB Upgrade OP-410-8101 ....$151
2MB Board OP-410-8102+8103 ....$171
PowerMate 386/20, 25
2MB APC-H655 ....$219 8MB APC-H656 ....$599
PowerMate 386/33E, 486/25E
2MB OP-410-5101 ....$171

DeskPro 386-20, 25, 386-20e, 25e
1MB 113131-001 ....$62 4MB 113132-001 ....$167
DeskPro 386s/16
4MB 112534-001 ....$194
4MB brd 113634-001 ....$287
DeskPro 3/25s; 33i, 4/25iS, 33i, 66i, 20MH, 33MH, SX/20, 20M,
SystemPro LT and M Series
4MB 118690-001 ....$153
8MB 118877-001 ....$356
ProSignia PC Server 466/33; DX2/66
16MB 149320-001 ....$610
32MB 149147-001 ....$1152
DeskPro 386-33, 486-33, SystemPro and SystemPro E series
2MB 115144-001 ....$109
8MB 116561-001 ....$376

LASER PRINTER MEMORY

Canon LBP-4
1MB n/a ....$109 2MB n/a $159
Canon LBP-8II, IIR, IIT
2MB 563-1880 ....$139
Epson ActionLaser 1000, 1900
512K n/a ....$35 2MB n/a $99
Epson ActionLaser 1100
2MB n/a ....$109 4MB n/a $159
Epson ActionLaser 1600
4MB n/a ....$159 16MB n/a $609
HP LaserJet 4L
1MB C2024A $48
HP LaserJet IIP, III, IIIP, IIID
2MB 33475B ....$95 4MB 33477B $169
HP LaserJet II, IID
2MB 33444B ....$95 4MB 33445B $169
HP LaserJet IISi, 4, 4M, 4Si, 4SiMX, 8000, Deskjet 1200c
1MB C2065A ....$48 2MB C2064A $94
4MB C2065A ....$174 8MB C2066A $339
HP LaserJet 4P, 4MP, Color LaserJet
2MB C3133A ....$95 4MB C3132A $179
HP Deskjet 500, 500C, 520, 520C, 550C, 660, 660C
256K 227078 ....$40
IBM/Lexmark Laser 4019 (all models)
2MB 1059675 ....$107 3.5MB 1039137 ....$167
IBM/Lexmark Laser 4029 (all models)
2MB 1181334 ....$87 4MB 1181335 ....$157
IBM/Lexmark Laser 4039, 4079 (all models)
4MB 1328365 ....$157 8MB 1328365 ....$319
OkiLaser 400
1MB 70014701 ....$69 2MB n/a $97
OkiLaser 400e, 410e
2MB n/a ....$117 4MB n/a $197
OkiLaser 830, 830 Plus, 840
2MB n/a ....$124 4MB n/a $209
Panasonic LaserPartner 4400, 5400
2MB KX-PEM1 ....$110 4MB KX-PEM2 ....$264
Panasonic LaserPartner 4410, 4430
2MB KX-P414 ....$115 4MB n/a $196
Panasonic LaserPartner 4450i, 4420
2MB KX-P441 ....$116 4MB n/a $187
Texas Instruments MicroLaser XL
1MB 2955739-0001 ....$49

LAPTOP AND NOTEBOOK MEMORY

AST

Ascentia 800n, 810n
4MB $185
8MB $359
16MB $609
Ascentia 900n, 910n
4MB $205
8MB $359
16MB $609
Bravo NB 486
4MB $169
16MB $599
PowerExec 4/25SL, Color, Plus
4MB $185
16MB $629
PowerExec 3/25SL, 3/25SL-C, EL
4MB $149
16MB $629
Premium Exec 386SX/20; 25, 25C
4MB $160

IBM

ThinkPad 220
4MB $238
ThinkPad 230Cs
8MB $409
ThinkPad 300
8MB $359
ThinkPad 340, 355, 360, 750
4MB $168
8MB $309
16MB $651
ThinkPad 510
4MB $199
8MB $399
ThinkPad 700, 720, 755 and CL/57SX
4MB $199
8MB $579
16MB $669
32MB $1399
ThinkPad 710T
4MB $179
8MB $315
N51 Notebook
2MB $95
4MB $179
I.A(e)SX, N33SX, PS/Note 102
4MB $146
8MB $288

ZENITH

Z-Note 320L; Lb, 325L, Le
2MB $95
8MB $298
Z-Note 425 Series
4MB (3.3 V) $155
8MB (3.3 V) $369
Z-Sport 4205, 4255
4MB $189
Z-Sport 3255
4MB $189
MasterPort 386SL, SLC, SLe
2MB $85
MasterPort 396SX
2MB $85
Z-Star
4MB $159
8MB $369

TEXAS INSTRUMENTS

TravelMate 3000 (all models)
2MB $79
TravelMate 4000 (all models)
4MB $189
16MB $959
TravelMate 4000M
4MB $198
16MB $799

WHY ADD MORE MEMORY?



Most applications run satisfactorily with 8MB, but in the long run 16MB is recommended

- Memory allows Windows & OS/2 to run faster
- Reduces your system's need to access the hard disk
- Utilize numerous & extensive applications at the same time

NEC

Versa S
4MB $199
8MB $319
UltraLite Versa (all models)
4MB $189
8MB $349
16MB (3.3 V) $619
UltraLite IL, SL/25C
2MB $95
6MB $329
8MB $349
UltraLite SL/20, SL/20P
2MB $85
6MB $279
ProSpeed 20i, 386SX/16
4MB $179

COMPAQ

Contura Aero 4/25, 4/33c
4MB $179
8MB $299
Concerto 4/25, 4/33
4MB $175
8MB $365
Contura 3/20, 3/25, 3/25e
4MB $148
8MB $298
Contura 400 models
4MB $180
8MB $365
16MB $651
Contura 4/25, 4/25ce, 4/25c
4MB $169
8MB $298
16MB $635
LTE Elite
4MB $174
8MB $515
16MB $598
LTE Lite 20, 25, 25c, 25e
4MB $300
8MB $549
16MB $729
LTE Lite 4/25c
4MB $180
8MB $339
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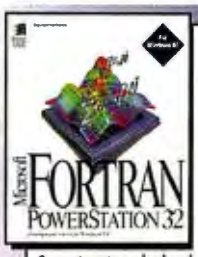
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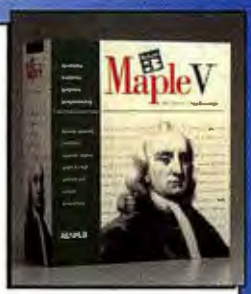


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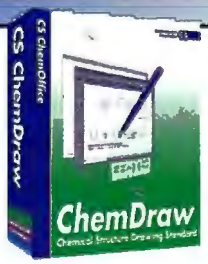
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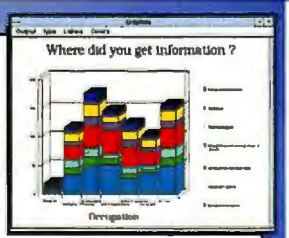
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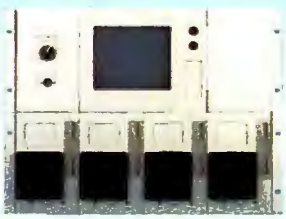
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6450128/92G7200 (4Meg)	Value Point 77 486DX2, 486SX, SVR 85 57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2123, 2133, 2155, Val Pt 77, 486CS2, 486SX, SVR85 Value Point 77 486DX2, 486SX, SVR 85	175.00
6450129/92G7428 (8Meg)	35SX, 40SX	339.00
6450130/92G7202 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	339.00
6451158/92G7208 (4Meg ecc)	486, 95XP, 55A (install in pairs)	199.00
6451159 (8Meg ecc)	486, 95XP, 55A (install in pairs)	399.00
92G7209/32G3720 (16Meg ecc)	9595 GPT	749.00

IBM NOTEBOOK & LAPTOP MEMORY

07G1415/07S1429 (4Meg)	Thinkpad 750, C, 700, C, 720, C, CL57SX	189.00
07G1416/07S1421 (8Meg)	Thinkpad 750, C, 700, C, 720, C, CL57SX	369.00
56G0095 (16Meg)	Thinkpad 750, C	699.00
56G0094 (4Meg)	Thinkpad 755, 360, 355, 340, 450	179.00
56G0094 (8Meg)	Thinkpad 755, 360, 355, 340, 450	349.00
56G0094 (16Meg)	Thinkpad 755, 360, 355, 340, 450	629.00
8189096 (4Meg)	Thinkpad 500, 510CS (3.3 volt)	209.00
8189099 (8Meg)	Thinkpad 500, 510CS (3.3 volt)	389.00
81B9113 (16Meg)	Thinkpad 510CS (3.3 volt)	799.00
79F0999 (2Meg)	LX40, N33SX, PS Note	103.00
79F1000 (4Meg)	LX40, N33SX, PS Note, Tkpd 350, 350c, PS Note 425	169.00
79F1001 (8Meg)	LX40, N33SX, PS Note	349.00
Hard Drive (524Meg, 710 Meg)) (4Meg/16Meg)	Thinkpad 750, 755, 360, 355 Thinkpad 755 Dimm Modules	949.00/1149.00 208.00/639.00
(4Meg/16 Meg w/Adap	Thinkpad 755	289.00/749.00
60G0378 (8Meg)	Thinkpad 350, 350c, PS Note 425	339.00
60G0379 (16Meg)	Thinkpad 350, 350c, PS Note 425	569.00
92F8894 (2Meg)	N45SL	109.00

COMPAQ MEMORY MODULES

MODEL		AMT. UPGRADED	CMPQ PART #	PRICE
DeskPro 386/33, 386/33L, 486/25, 486/33L, 486/50L, System Pro		2Meg Module	115144-001	109.00
		8Meg Module	116561-001	399.00
		32Meg Module	116568-001	1399.00
DeskPro 386/33L, 486/33L		(Exp Bd)	116569-001	279.00
DeskPro 386/25 385/20		1Meg Module	113131-001	79.00
		4Meg Module	113132-001	199.00
DeskPro 386S-16MHz		1Meg Exp Bd	113633 001	149.00
		4Meg Exp Bd	113634-001	279.00
		1Meg Module	113646-001	79.00
		4Meg Module	112534-001	199.00
DeskPro 386/20E		1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E		4Meg Exp Bd	113645-001	279.00
		1Meg Module	113131-001	79.00
DeskPro 286N, 386N, 386SX20, all "M" series, sytem LT series, all "I" series		4Meg Module	113132-001	199.00
		1Meg Module	118688-001	59.00
		2Meg Module	118689-001	89.00
		4Meg Module	118690-001	169.00
		8Meg Module	118787-001	309.00
M Series Exp Bd		0-64Meg	129160-001	189.00
DeskPro 386/16		1Meg Kit	108071-001	99.00
		4Meg Kit	108072-001	299.00
		1-2Meg Kit	108069-001	239.00
		4-8Meg Exp Bd	108070-001	437.00
DeskPro 286		512K Kit	113012-001	49.00
DeskPro 5/60, 5/66M, 5/66M	ALL OF THESE MACHINES USE THESE MODULES	8Meg Kit	149911-001	369.00
Prosignia 200		16Meg Kit	149949-001	699.00
Proliant 100 5/60		32Meg Kit	149912-001	1356.00
Proliant 2000 4/30, 5/66		64Meg Kit	149913-001	2515.00
Proliant 4000 4/50, 5/66		128Meg Kit	149914-001	5799.00
Prolinea 386 3/25S, 3/25ZS		2Meg	141738-001	90.00
		8Meg	141742-001	316.00
Prolinea 486 4/25S, 4/33, 4/50, 4/66, CDS		2Meg	141683-001	95.00
Enhanced Prolinea, Prosario series		4Meg	141684-001	175.00
		8Meg	141685-001	339.00
Prosignia PC Server, 486/33, 486 DX2/66		8Meg	141685-001	339.00
		16Meg	149320-001	599.00
		32Meg	149147-001	1199.00

COMPAQ LAPTOPS & NOTEBOOKS

LTE/286	4Meg Bd	117061-033	179.00
LTE/386S/20	4Meg Module	121125-002	209.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	209.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	389.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	769.00
LTE LITE 425C/33C/25E/25L	4Meg Module	142337-002	189.00
LTE LITE 425C/33C/25E/25L	8Meg Module	142337-003	329.00
LTE LITE 425C/33C/25E/25L	16Meg Module	142337-004	639.00
SLT/286	4Meg Module	110237-001	199.00
SLT/386	2Meg Module	118304-001	109.00
SLT/386	4Meg Module	118305-001	219.00
Concerto, LTE Elite	4Meg	144790-001	189.00
	8Meg	144790-002	369.00
	16Meg	144790-003	699.00
Contura 320, 325	2Meg	139497-001	99.00
	4Meg	139498-001	189.00
	8Meg	139499-001	339.00
Contura 400, 410	4Meg/8Meg/16Meg		199/369/709
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	189.00
	8Meg	146521-001	339.00
	16Meg	146531-001	699.00
Aero 4/25, 4/33L	4Meg	190532-001	184.00
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T2000SX/2200SX/T1800 1850, C 4Meg		PC-PA2001U	189.00
T2000SX/2200SX/T1800, 1850, C 8Meg		PC-PA2002U	359.00
T4400SX, SXC T6400, T6600	4Meg	PC-PA2004U	189.00
T4400SX, SXC T6400, T6600	8Meg	PC-PA2005U	359.00
T4400SX, SXC T6400, T6600	16Meg	PC-PA2010U	689.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	199.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	389.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg	PC-PA2014U	769.00
T4700, 4800, 4850 (Hard Drive)	524Meg/710Meg		949/1149
T3400CT, T2410, T3600	4Meg	PC-PA2019U	194.00
T3400CT, T2410, T3600	8Meg	PC-PA2020U	359.00
T3400CT, T2400, T3600	16Meg	PC-PA2021U	707.00
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T3200SX	4Meg	PC12-PA8909	109.00
T5200/T8500	2Meg	PC13-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	419.00

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MODEL	AMT. UPGRADED	MANU. PART #	PRICE
ACER 700, 730C, 760, 780	2Meg/4Meg/8Meg		109/209/399
ACER 750	4Meg/8Meg/16Meg		199/349/799
ALR Venture	4Meg	12407980	249.00
Altima Voyage	4 Meg/16 Meg		199/679
Altima Voyage II	4Meg/8Meg/16Meg		199/369/679
AST Ascentia 900N, 800N	4Meg/8Meg/16Meg		199/379/679
AST Bravo 4/25LX	4Meg	591255-001, -002	189/379
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500614-003	189.00
AST Power Exec 386SX, 425cL, 425SL	4Meg/16Meg	500198-001, -002	189/799
AST Power Exec 433SL	4Meg/8Meg/16Meg	501131-001,002	194/369
AT&T Globalist 230	4Meg/8Meg/16Meg		199/389/679
AT&T Safari NSX 20	4Meg	PEC 37851	259.00
Austin DX4, DX2, SX2, SX Series	4Meg/16Meg		Call
Beadwell 8310, Plus	1Meg	23050-09100	59.00
Beadwell 8310C SS	1Meg		109.00
Beadwell 8310C SX	4Meg		229.00
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Canon Innova 486	2Meg/4Meg/8Meg		109/209/449
Canon Innova 486-16	4Meg/16Meg		189/829
Canon Notewt 486	4Meg/16Meg		199/1849
Chiplet 486	4Meg/16Meg		189/879
Chicony N85	4Meg/16Meg		199/879
Compaquad 425TX Notebook	4Meg/16Meg		Call
Contura 410c & cx	4Meg/8Meg/16Meg		199/389/679
Dell Latitude M, MC, MCX	4Meg/8Meg/16Meg		219/449/719
Dell Latitude XP, 425, 433C, 4100CX	4Meg/8Meg		189/649
Dell Latitude 486 425, 433C, 433CX, 450, 450CX	4 Meg/16 Meg		199/679
DTK 4170DP Notebook	4Meg/8Meg/16Meg/32Meg		Call
Epson ActionNote 600, 650c	4Meg/8Meg/16Meg		209/399/599
Epson ActionNote 700, 700c, 700cx	4Meg/16Meg		199/539
Epson ActionNote 4000 Notebook	8Meg		799.00
Epson ActionNote 4LC/25, 4LC/33, 4SLC/2-50			Call
Everex Tempo LX, LX20, Carrier	2Meg	PCA 00853-0001	109.00
Gateway 2000 Colorbook 4/33	4Meg/16Meg		199/679
Gateway 2000 Nomad 425 DX/LSXL	4Meg/16Meg		199/1199
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Grid 1720, 1750, 1755	4Meg		59.00
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HP OmniBook 330, 600	4Meg/8Meg/12Meg		229/439/769
HP OmniBook 4000	4Meg/8Meg/16Meg		199/379/649
Leading Edge 3000	4Meg/16Meg		199/679
Leanmark SE10	4Meg/8Meg		299/399
Magnavox Metalite	1Meg/4Meg	286, 386SX	119/199
Midwest Micro Elite SX-25, SX33, DX2-50, DX2-66	4Meg/8Meg/16Meg		199/399/619
Midwest Micro Elite 486 SLC 33 Subnotebook	4Meg/8Meg/16Meg		199/399/599
Midwest Micro Elite 3000 340 HE 134 R, 364 HE	4Meg/8Meg/16Meg		199/399/649
Midwest Micro Elite Smith Plus DS-75, DS-90	4Meg/8Meg/16Meg		199/399/579
NCR Safari 3180	4Meg/ 8 Meg		239/449
NEC Prospeed 286	2Meg	PC31-21	119.00
NEC Prospeed 386	8Meg	PC31-22	399.00
NEC Prospeed 286, 386SX-16, 386SX-20	2Meg	PC21-22, PC21-32	99.00
NEC UltraLite Versa E, V	4 Meg/8Meg/16Meg/20Meg	DP4104	183/359/719/915
NEC Versa Removable Hard Drive	340Meg/524Meg/710Meg		749/899/1249
NEC Versa	4Meg/8Meg/16Meg		209/379/799
Packard Bell 386SX, 286	1Meg, 4Meg	286, 386SX	99/199
Packard Bell Statesman	2Meg/8Meg		119/369
Panasonic CF-27, CF-273, CF370	4Meg	CF-BA185	59.00
Panasonic CF380, CF480	2Meg/4Meg/8Meg		119/199/309
Panasonic CN-VT1F, DF-580	4Meg/16Meg		219/819
Sanyo 1718 NB		MBC-N6MEM2	109.00
Sharp 6781, 6981, 6785, 6700, 6800, 6741	2Meg/4Meg		109/199
Sharp 6750, 6850, 6860, 7700, 7760	4Meg/8Meg/16Meg		199/679
Sharp 8700 & 8800	4Meg/8Meg/16Meg		199/379/649
Shiraz PC-6220	16Meg	PC 6218	79.00
TI Travelmate 3000C	2Meg	2568094-0001	79.00
TI Travelmate 3000	2Meg	2566596-1	84.00
TI 4000, TI 4000E	4Meg/16Meg		199/559
TI 4000D	4Meg/8Meg/16Meg		219/799
Tandy 1510, 2810, 3810	2Meg		49.00
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Twinhead, Atrima, Computrix 486SX, DX Tandy 4000	4Meg/16Meg		199/679
Twinhead Slimnote 5	4Meg/8Meg/16Meg		199, 379, 649
Ultra 486 TSX8	4Meg/8Meg/16Meg		249/449/699
Zeos 386SX Notebook (not the + version)	2Meg		109.00
Zenith Master Sport 386SX	2Meg	ZA-300-1	114.00
Zenith Master Sport DSL, SLE, 600, 620, 625NL	2Meg	ZA-4-4	114.00
Zenith Super Sport 286, 286E	1Meg	ZA-180-86	99.00
286E, SLE	2Meg	ZA-180-84	149.00
SX Alpha/SX Beta	4Meg	ZA-180-86/ZA-180-87	199.00
Zenith Z-Note 425LN, LNC, LNP	4/8/16Meg		209/469/839
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Canon LBP 860	–	–	–	99	–	–	170	–	–	349	669	1249
Canon LBP-4, 4L, 4plus	–	159	219	259	–	–	–	327	–	–	–	–
Epson 6000, Action Laser	–	–	139	–	–	–	229	–	–	–	–	–
Epson Action Laser 1100, 1600	–	–	89	99	–	–	189	–	–	379	599	–
Epson Action Laser II	–	–	89	–	209	–	–	327	–	529	–	–
Epson 8000	–	–	89	–	209	–	–	327	–	–	–	–
Epson 1000, 1500, 5000, 5200	–	–	–	*Call*	–	–	*Call*	–	–	–	–	–
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HP 3, 3D, 3P, 2P 2P+	–	–	–	99	–	–	169	–	–	–	–	–
HP 4, 4M, 4SI, 4SiMX, 4P, 4MP	–	–	–	89	–	–	169	–	–	349	–	–
HP 4L	–	59	–	–	–	–	–	–	–	–	–	–
HP 3Si	–	89	–	–	–	–	169	–	–	349	–	–
HP 4Si	–	–	–	89	–	–	179	–	–	349	–	–
HP Design Jet 600, 650, 200	–	–	–	89	–	–	175	–	–	349	–	–
HP Deskjet 500, 500C, 510, 550,560	–	55	–	89	–	–	175	–	–	349	–	–
HP Deskjet 1200C, 1200C/P	–	–	–	89	–	–	175	–	–	349	–	–
HP Paintjet XL300	–	109	–	–	–	–	289	–	–	459	837	–
IBM Laser 4019, 4019E	–	–	–	–	–	169	–	–	–	–	–	–
IBM Laser 4029, 4037	–	–	–	–	–	–	169	–	–	–	–	–
IBM Laser 4039, 4079	–	–	–	99	–	–	169	–	–	350	–	–
Konica IP-3110	–	–	119	189	239	–	–	–	–	–	–	–
NEC 90, 290	–	–	–	99	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	99	–	–	–	–	–	–	–	–
OKI 400	–	–	–	89	–	–	84	–	–	–	–	–
Oki 400E, 400EX, 410E, 410EX	–	–	135	169	–	–	179	–	–	349	–	–
Oki 830, 840	–	–	–	109	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	159	–	–	227	–	–	–	–	–
Packard Bell 9815	–	–	–	159	–	–	227	–	–	–	–	–
Panasonic 4420/4450	–	–	–	129	–	–	229	–	–	–	–	–
Panasonic 4410/4430	–	–	–	129	–	–	185	–	–	–	–	–
Panasonic 4450	–	–	99	–	–	–	–	–	–	–	–	–
Panasonic 4400/5400	–	–	89	129	–	–	229	–	–	–	–	–
Panasonic 4400, 5410	–	–	109	179	–	–	249	–	–	–	–	–
Sharp 9400, 9460, 9600, 9700E	–	–	89	149	–	–	249	–	–	–	–	–
Sharp 9500, E, H, 9700, H	–	–	109	–	–	–	279	–	–	–	–	–
TI XL/PS17/PS35	–	–	35	–	–	–	–	–	–	–	–	–
TI Microlaser Pro E, Powerpro, Pro 600	–	–	89	139	–	–	229	–	–	429	–	–
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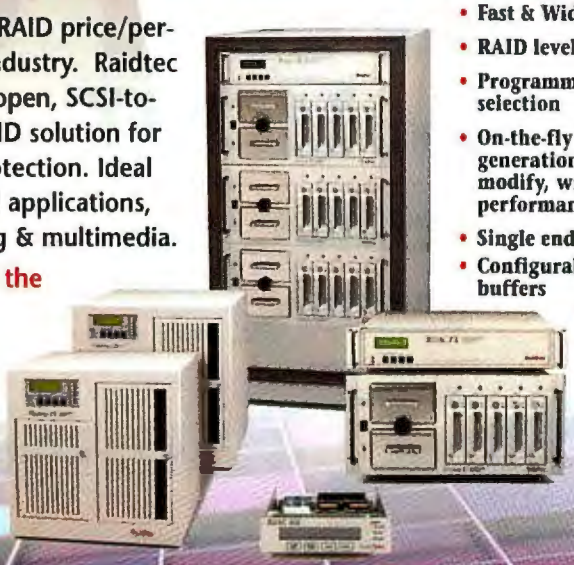
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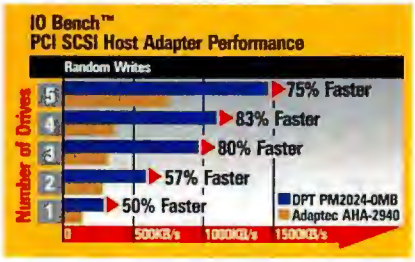
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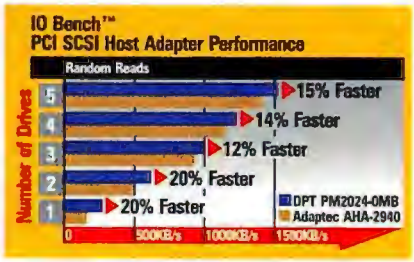
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Orchestra MultiSystems, Inc. has already won favorable reviews for its first 17" display, The Tuba, in PC Magazine ("Budget minded buyers should check out... Orchestra MultiSystems' The Tuba"— Sept. 27, 1994) and CD-ROM Today (Ultimate Upgrade for Multi-media/Monitors— Jan. 1995).

Windows-using Tuba owners agree that The Tuba's 0.26mm dot pitch screen, 1600x1200 non-interlaced maximum resolution, micro-processor controls, edge-to edge display, Energy Star & MPR-II compliance, all with street price of well under $699, gives them a high-value big-screen solution.

Now, with The French Horn II and The Tuba II, Orchestra is ready to bring down the curtain on other 15" and 17" displays. These new performers have all the features of The Tuba, plus they add on-screen controls for adjustments to the following image characteristics:

- Pincushion / Barreling
- Color Balance (RGB)
- Color Temperature
- Trapezoid
- Tilt/Rotation

	Tuba II	NEC 5FGe	NEC 5FGp	MAG DX17F	VIEWSONIC 17	VIEWSONIC 17G
Dot Pitch (mm)	0.26	0.28	0.28	0.28	0.27	0.28
Maximum Resolution (Non-Interlaced)	1600 x 1200	1024 x 768	1280 x 1024	1280 x 1024	1600 x 1280	1280 x 1024
Trapezoidal Control	YES	NO	NO	NO	YES	YES
Tilt/Rotation Control	YES	YES	YES	YES	YES	NO
Pincushion Control	YES	YES	YES	YES	YES	YES
Color Balance Control	YES	NO	YES	NO	YES	YES
Color Temperature Control	YES	NO	NO	NO	YES	YES
Microprocessor Controls	YES	YES	PARTIAL	PARTIAL	YES	PARTIAL
On-screen Controls	YES	NO	NO	NO	YES	YES
E.S.P.	$699	$1045	$1175	$799	$1045	$945

With all of these adjustments available to the Tuba II user, slight image imperfections due to shipping or environmental factors are eliminated, virtually assuring total product satisfaction for a suggested list price of $699.

If $699 is still a bit high, or space limitations dictate a smaller monitor, The French Horn II 15" model, with the same advanced features as the Tuba II, is available for a suggested list price of $499. The French Horn II has a 0.28mm Flat Screen, and will fit into any monitor budget. The Fat Lady is singing for us; let Orchestra perform for you.

For more information on the Tuba II, French Horn II or other Orchestra products, call us at (800)237-9988.

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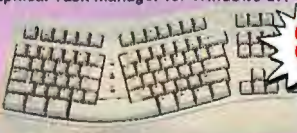
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The **Firenze** (US$19.95 or 29,000 lire) CD-ROM is good under its own software and one of the best as a source of eye candy with the Corel screen saver. Contact **C D Hardware**, LaSpezia, Italy, +39 187 515604; fax +39 187 513828. **Circle 1163.**

Gazillionaire ($32.95) is an important game because it was written in Visual Basic and is played from a CD-ROM. Contact **Spectrum Holobyte, Inc.**, Alameda, CA, (800) 695-4263 or (510) 522-3584; fax (510) 522-3587. **Circle 1164.**

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The critical machines at Chaos Manor have been protected by **OnGuard UPSes** ($477 to $2690) for several years, and I have not regretted it. Contact **Clary Corp.**, Monrovia, CA, (800) 442-5279 or (818) 359-4486; fax (818) 305-0254. **Circle 1168.**

RAM Doubler 1.5.1 ($99) is cheap compared to adding silicon to your system, and we haven't seen anything it doesn't work with. Contact **Connectix Corp.**, San Mateo, CA (800) 950-5880 or (415) 571-5100; (415) 571-5195. **Circle 1169.**

The game of the month is the Windows version of **Sim City 2000** (floppy disk version, $54.95; CD-ROM version, $69.95). Contact **Maxis**, Orinda, CA, (800) 336-2947 or (510) 254-9700; fax (510) 253-3736. **Circle 1170.**

The **Star Reach** ($49.95) box is gorgeous—it looks like a spaceship. Contact **Interplay Productions, Inc.**, Irvine, CA (800) 969-4263 or (714) 553-6655; fax (714) 252-2820. **Circle 1171.**

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of specialized database CD-ROMs. Some are still useful, and some very much so. The interface to those databases remains plain vanilla. It's worth being on Quanta's mailing list, but don't look to them for the latest multimedia CD-ROMs.

The computer book of the month is by Gene K. Landy, *The Software Developer's and Marketer's Legal Companion: Protect Your Software and Your Business* (Addison-Wesley, 1993). This goes into copyright, beta-test agreements, and much more. The book of the month is by Jack Cohen and Ian Stewart, *The Collapse of Chaos: Discovering Simplicity in a Complex World* (Viking, 1994). Jack Cohen is a professor of biology in England. He was a principal consultant to Larry Niven, Steve Barnes, and me for *Legacy of Heorot* and our upcoming sequel, *Beowulf's Children*. The book is an investigation into how you can evolve simplicity from a complex world. This book isn't easy reading, but I bet you like it.

The game of the month is the Windows version of Sim City 2000 from Maxis. When I play Sim City, I cheat: I've figured out where they store the amount of money you have, and I use the Norton Utilities disk editor to go in there and give myself a lot more. It's fun to be bountiful to my simulations.

Next month, with luck, I'll have something on Windows 95, and meanwhile, the software keeps rolling in. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

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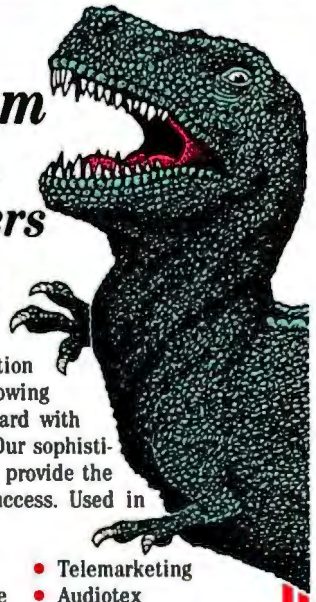
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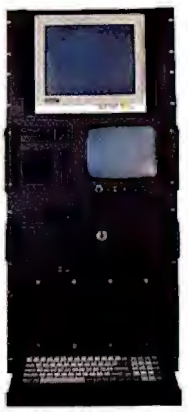
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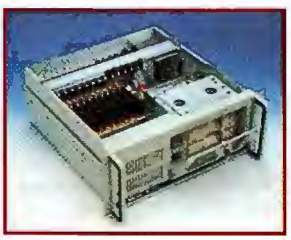
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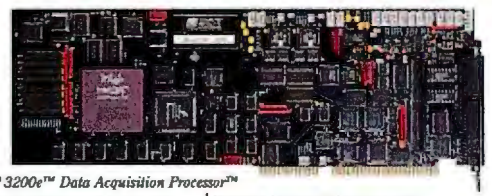
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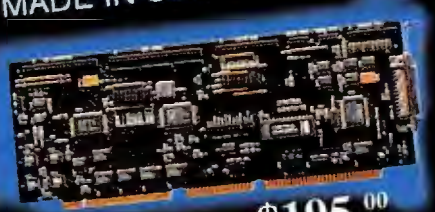
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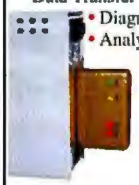
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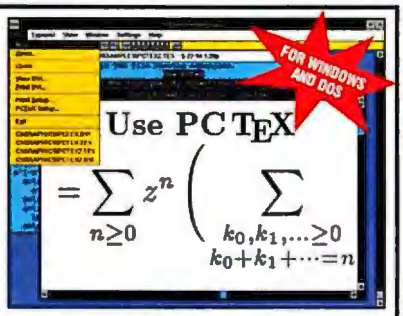
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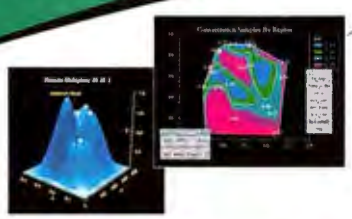
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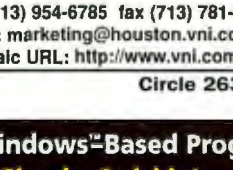
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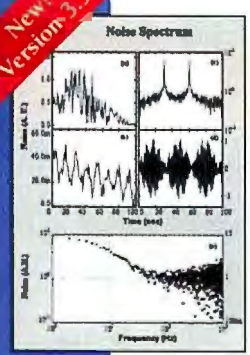


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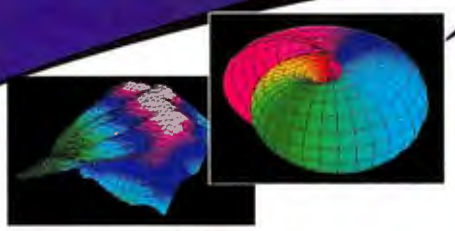
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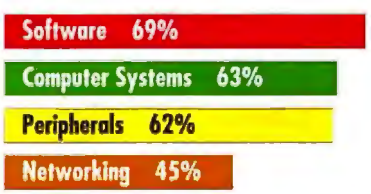
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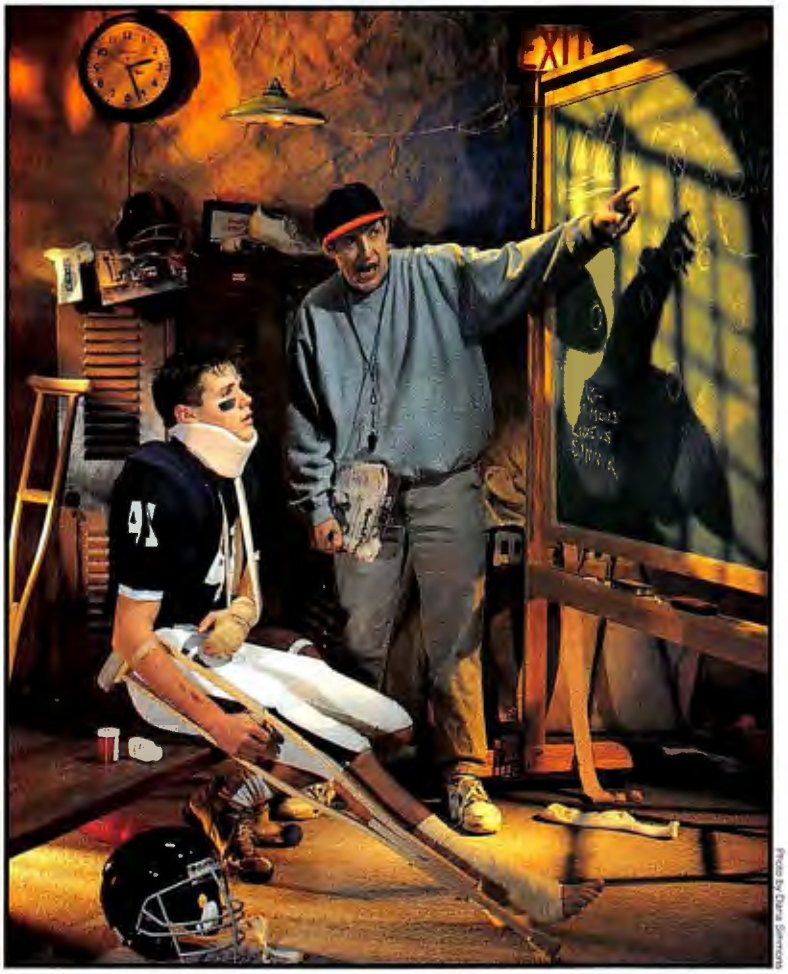


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So, Where's the IT Payoff?

Spend $1 trillion and what do you get? Productivity payoff—or just deeper in debt?



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Businesses that expected a big productivity payoff from investing in IT (information technology) are, in many cases, still waiting to collect. Numerous studies indicate how frequently this has been the case, despite massive investments over the past 25 years. During the past decade, businesses have invested $1 trillion in technology—but economic productivity has remained stagnant.

Those who see a productivity payoff argue that it debunks the productivity paradox. However, a careful analysis shows that any payoff can be attributed more to changes in management practices—downsizing, business reengineering, foreign outsourcing—than to use of technology.

So, the productivity paradox does indeed exist. But what causes it? Most readers long on computer experience must have had that nagging feeling that all is not right in computerland—that maybe writing your own letters because you now have a word processor, instead of having the office secretary do it, and doing your own desktop publishing aren't all they're cracked up to be. The time spent learning some of these programs can be counterproductive. However, this is just the tip of the iceberg and a superficial cause of the productivity bust.

Aside from the obvious, such as poor management, lack of experience, and poor use of tools, the biggest productivity inhibitors, surprisingly, are external.

Commercial software is a good example. It's extremely buggy. This wasn't always the case. The age of the mainframe was the age of quality software. Today's competitive "get it out the door before they do" mentality forces beta-quality software on users who expect production quality. The Intel Pentium debacle is just the latest bug perpetrated on us. Underlying flaws are found in just about every piece of personal computer software being sold today. There is not one among us who has not experienced these little peculiarities—from compression programs eating entire hard disks to conflicts between device drivers. All these diminish our productivity.

Aside from an extremely high number of bugs in its software, the personal computer has also spawned an almost unimaginable number of people professing expertise in its deployment. The problem is twofold. One, many consultants are not the experts they claim to be. Two, the personal computer consultant is about as useful as the mainframe consultant. Both know only half the equation. Both will provide only those solutions they excel in. In other words, hire a consultant with dBase experience, and you get a dBase solution.

Of course, there is nothing wrong with dBase consultants. The problem is that organizations often hire anyone carrying a laptop and having a good command of technospeak. What they get is seldom a productive solution to their business problem.

Larger companies armed with professional MIS staffs have the wherewithal to make better technology decisions and hence have a better chance of increasing productivity. But even these larger organizations are at risk.

Not everyone is an expert at everything, so the dutiful MIS type leans heavily on advice gleaned not from his or her peers but from trade publications. This is a fatal flaw. If you compare other industries to the computer industry, you'll notice a disturbing trend. In most other industries, the trade magazines and newsletters are edited and written, for the most part, by industry experts. On the other hand, the majority of computer-industry magazines and newsletters are written by journalists and freelancers with little technology experience.

Not too long ago, I read an article in a major industry weekly about building an expert system. Being somewhat of an expert in this particular area, I closely examined the freelanced article. I found no fewer than 20 mistakes. The danger here is that nonexperts reading this article are taking flawed advice—with ramifications that can seriously affect the bottom lines of their organizations.

A few thousand years ago, the Romans had some good advice for those venturing into the marketplace armed with many dollars but little experience. Eloquent sounding in Latin, caveat emptor is especially meaningful for those searching for the high road to productivity today. Let the buyer beware. ■

Jessica Keyes is president of New Art Communications, a consulting firm based in New York City. She formerly was managing director of technology for the New York Stock Exchange. She is the author of seven books, including The McGraw-Hill Multimedia Handbook *and* Solving the Productivity Paradox. *You can reach her on BIX c/o "editors" or on the Internet at newart@panix.com.*

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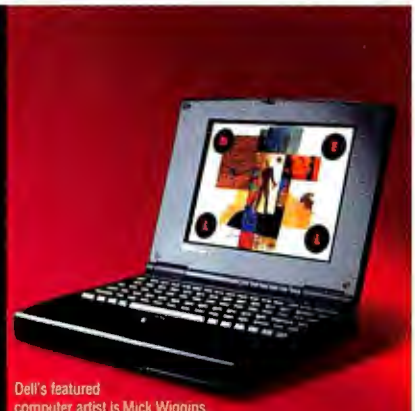
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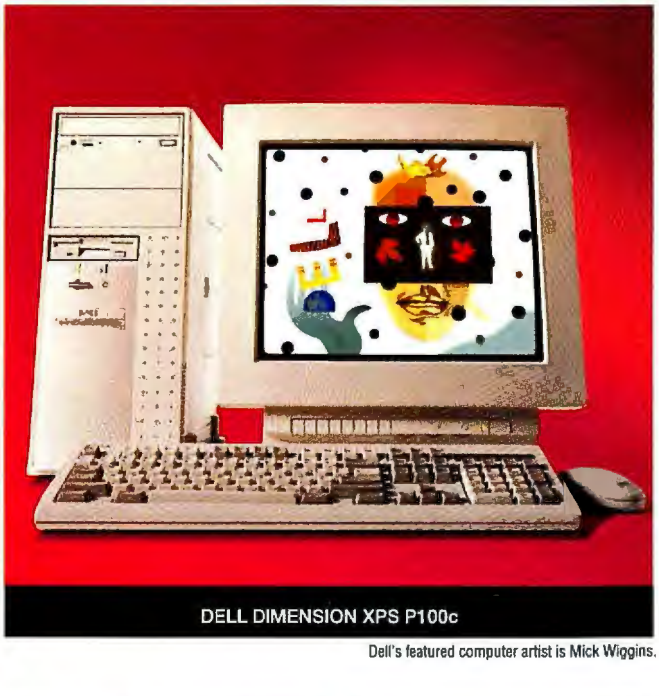
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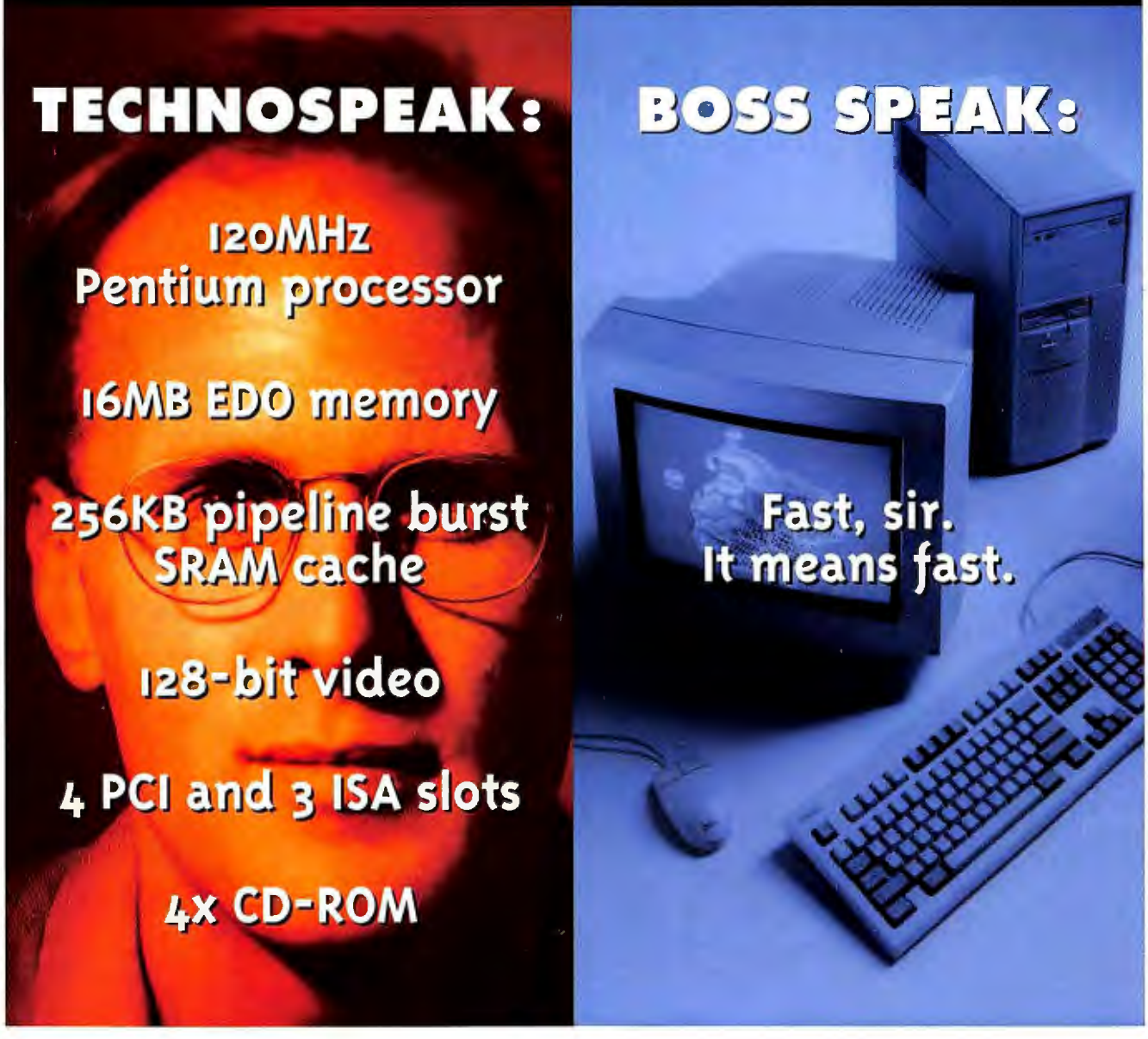
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